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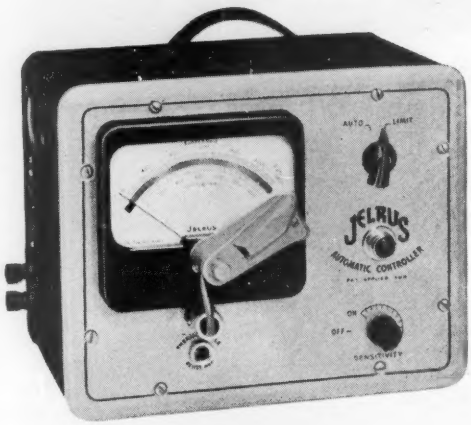

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The 84th Congress: Health and Medicine

Now that Congress has adjourned, and many of the bills passed have been signed by the President to become public laws, it is desirable to see what was done. Although not all of the President's proposals in the field of health and medical research were enacted into law, a substantial program was put through. Here are some of the highlights.

The Department of Health, Education, and Welfare has the responsibility for a large part of the health activities of the Government. It received the impressive appropriation of $2366 million, of which $441 million is to be allocated to the Public Health Service. The appropriation for the National Institutes of Health, a division of the PHS, had an interesting history. The budget request was for $126 million; the House raised this to $135 million and the Senate added another $49 million to bring the total to $184 million. There was some debate about the ability of the NIH to use funds so greatly in excess of the budget request, but, as was reported by Senator Hill, "eminent doctors and scientists" gave assurances that the money could be "prudently and wisely spent." There would be a greater question about this if NIH had to absorb the increase itself, but almost all of the additional funds will be used for grants in support of research in medical schools, universities, and other research institutions. The past record of NIH in disbursing grants gives us confidence that the money will indeed be "prudently and wisely spent" without any lowering of the standards to be met in qualifying for grants.

The Armed Forces Medical Library will become a National Library of Medicine, an overdue change to which we earlier gave editorial support [*Science* **123**, 869 (18 May 1956)]. The law as finally enacted transfers the library from the Department of Defense to the Public Health Service under the control of a board of regents. The Surgeon General of PHS is authorized, "in accordance with the direction of the Board . . . " to select a site and to erect and equip buildings for the library. There is now no doubt that the National Library of Medicine will soon become a reality.

Another major accomplishment was the enactment of a law to establish a National Advisory Council on Health Research Facilities. The council will be headed by the Surgeon General of PHS and will include a representative of the National Science Foundation and 12 members appointed by the Secretary of the Department of Health, Education, and Welfare. The law that established the council also authorized the expenditure of $30 million annually for 3 years (1957–59) on a 50-50 matching basis for construction of health research facilities by public or nonprofit institutions. A move by Representative Mack to amend the bill to provide medical training was ruled out of order. Mack said that training was "more important today than research because you cannot do research unless you train young men and women. . . . " In signing the bill, the President called the law "an important step forward" but criticized the bill for not providing for the construction of facilities for training medical scientists.

We agree with the criticisms of Representative Mack and the President, which point to what is a characteristic weakness in our support of education as well as research, both public and private, in the United States. We are inclined to put money more readily into facilities than into the development and support of people to man them.—G. DuS.

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Scientists and Engineers: Quantity plus Quality

Lee A. DuBridge

It is not my task in this paper to provide new statistical data on the current shortage of scientists and engineers in the United States. Rather, I wish to offer some opinions and points of view about the causes of the shortage and the possible cures for it. I shall try to state opinions that seem to be held by many scientists and engineers, and I take credit for no originality whatever. At the same time I am not representing any organization or group, so I must assume full personal responsibility or blame for all opinions herein expressed.

U.S. versus U.S.S.R.

First I should like to make a few remarks about the production of scientists and engineers in the United States as compared with the Soviet Union.

It is perfectly obvious, of course, that one of the principal reasons for the immediate shortage of technical personnel in the United States is the grave military and economic contest we must wage with the U.S.S.R. We must attempt to be strong enough as a nation and to have strong enough allies to discourage any aggressive attack by the U.S.S.R. on the free world. Obviously it is necessary that we keep fully and intimately informed of the Soviet activities and achievements, so that we can prepare ourselves efficiently and effectively for the most probable cold or hot war contingencies. Our task is to maintain our security in the face of the threat of Soviet military and economic power.

These things we take for granted. At the same time, I feel that a good many Americans are getting a little sick of hearing the argument that *we* must do this or that just because the Soviets are doing it. What the Soviets are doing may be very important in deciding what we should do, but to conclude that we must always *copy* what they do may be fatally wrong.

Now we really know this. We do not send thousands of people to concentration camps just because the Soviets do. Nor do we deprive farmers of their land or deprive men and women of the comforts of daily living in order that all raw materials, labor, and productive capacity may be devoted to building a military machine. In these and other things that destroy the initiative or freedom or happiness of the people, the Soviets, one might say, are "ahead of us"—and we are glad of it!

But how often the newspaper headlines blaze with that dread phrase: "The Soviets are ahead of us" in something or other. What does it mean? "Being ahead" implies some kind of a race in which the two contestants are on the same track and going in the same direction. If instead they are on different tracks or are headed in opposite directions, who is to say which is "ahead"?

For example, the Soviets are said to have more submarines than we have; they are "ahead" of us. Does this mean we must hurry to build as many submarines as they have? *Not necessarily!* Their submarines are presumably directed at our absolutely vital sea traffic. Their sea traffic may be relatively small and unimportant to them. Hence, our submarines would have little to do, unless they have other functions. What we need is something to kill their submarines.

One can think of many other examples. Sometimes we should be doing the same things they are doing; sometimes we should be doing just the opposite, or at least something different. And I propose abandoning entirely the expression, "The Soviets are ahead of us." It usually has no meaning, and it often implies a false conclusion. Instead, let us just get the facts about what they are doing—and then decide for ourselves what is best for us to do.

We often hear that in the U.S.S.R. more men and women received degrees in science and engineering last year than in the United States. So what? Maybe this is because in the past 100 years they have so neglected their technical strength that they must now exert strenuous efforts to build it up. If this is true, then our rate of production should not be determined by their weakness—only by our own. Let us ask how many engineers *we* need to do *our* job and not take over their figures for the numbers they require to do their job.

Now we do need more engineers to do our job, so let us do what we can at our task without getting hysterical about *their* numbers.

After all, we might ask, what else can an ambitious young man or woman prepare for in the U.S.S.R. other than science or engineering? There is no great need there for stock brokers or bond salesmen! for lawyers or bankers or preachers! There are not many opportunities for opening up a new business. Even if one could get labor and materials, there would not be many people to buy autos or television sets or swimming pools.

But over there a career in science or engineering offers something to strive for: a fine salary, a car, a home in the country, respect of the public, and praise from the government—all the inducements that a rich capitalistic society could offer! Naturally, the young students flock into science and engineering careers.

Possibly in a few years the Soviets will have enough engineers, and they will decide they need more economists, say, or plant managers or agriculturists. If so, the government can quickly turn its

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smiles and approbation—and its rubles—to these new fields (possibly executing a few scientists for emphasis). And, presto, the younger generation will take the hint and go in the new direction. And a host of Americans will then hold up their hands in horror and say, "Look what the Russians are doing; we must do that too."

Now I do not want to be misunderstood. I am fully aware of the needs for scientists and engineers in the United States. But I urge that we view our need in the light of our own requirements—not someone else's. Only if we do this can we evolve a sensible long-range program that will serve the welfare and security of America.

We cannot build the kind of a society we want unless we offer our young people opportunities to go into any field they want or in which their talents lead them. And we shall certainly suffer if not enough smart youngsters go into business, law, economics, or government. Whatever we do to obtain more scientists must not be done at too great expense to other vital fields or to the freedom of choice of the individual.

The Shortage Is Long-Range

Let us turn now to the nature of our shortage of scientists and engineers. We hear the opinion expressed that, "since a large fraction of our technically trained people are now engaged on military and atomic-energy projects, therefore, as soon as the present cold war is over and the Department of Defense stops spending so much money, there will be thousands of engineers out of jobs—and they will be a glut on the market as they were in 1932."

This argument should be looked at squarely, for, of course, it contains some truth. A sudden abandonment or a large cutback in our military and atomic-energy program would result at once in large unemployment among eningeers—and among almost every other class of worker too, from truck driver to stock broker. How long this setback to our booming economy would last, no one could foretell.

However, we must not be blinded to the real situation that now exists by a paralyzing fear of improbable things that *might* happen. If we think our economy is going to suffer a staggering setback for any reason, we should stop training businessmen, doctors, lawyers, engineers—everybody! We should even stop having babies! Because, in case of economic catastrophe, we will all be hit in the teeth, as everyone was in 1932.

So let us not try to predict the future of the cold war, or the future economic conditions in this country or in the world. Let us simply ask whether at any given level of general employment in the coming years the engineer and scientist will be relatively more scarce or more plentiful than other types of workers. After all, everyone must risk the general rises and falls of the business cycle. But we should not push people into areas that are more likely to be overcrowded.

Now it is to me perfectly obvious that, if we ignore temporary ups and downs, the long-term trend has been and must continue to be for an ever larger fraction of our working force to be engaged in scientific and technical pursuits. This becomes strikingly evident if we look back, say, 50 or 100 years. In the United States while the population has doubled (since 1900) the number of scientists and engineers has increased 10 times. The fraction of the workers in technical pursuits has thus risen 5 times. Granted that this past 50 years has been a period of phenomenal growth in technology, I can see no reason to expect that the fraction of technical workers will not continue to rise—limited eventually only by the fraction of the population that possess technical talents.

I think this continued increasing relative demand is indicated by many factors: (i) The technologic age, in the world as a whole, has just begun to arrive. The United States will have tremendous opportunities to assist in the spread of the benefits of technology to its own people and also to other parts of the world. (ii) In this country, as we go forward, more research and development will be needed to produce more technologic equipment, which will need still more trained men to manufacture, maintain, and use it. This spiral will continue upward, limited only by our ultimate supply of brains. The frontiers of science have no foreseeable limit. (iii) As our industrial society progresses, we are using up at an ever-increasing rate the supply of easily obtainable raw materials with which nature provided us. We must dig ever deeper for our coal, iron, copper, oil, and other materials; we must process ever lower and lower grade ores at an ever-increasing cost in energy consumed and with an ever more intricate technology. We must find and make new materials, develop new sources of energy, take increasingly more elaborate precautions to attain adequate supplies of fresh water and pure air. Thus each and every person in the industrialized world will consume more energy, more natural resources, and the technologic needs must then rise always faster than the population. Even to keep pace with the rising population will be hard enough.

All these things will be true in the long run, whether or not the cold war continues or the military program is reduced. Even today a large fraction of those engaged in military work could very easily be fully absorbed in peacetime pursuits.

This picture can be changed, it would seem, only by the colossal disaster of an all-out nuclear war, which would set civilization back 100 years. Perhaps, as Harrison Brown points out, the world then without its once "cheap" sources of materials and energy could never return to its present state of existence.

The conclusion I wish to emphasize is simply that in the very nature of things we face the necessity, for a long time to come, to encourage and develop to the fullest all of our human brainpower in scientific and technical fields—and indeed in all other fields too. It is a long-range problem as well as a short-range one and justifies long- as well as short-range measures to solve it.

It would seem to me to be a relatively safe prediction that in 20 years—barring a world catastrophe—we will need twice as large a *fraction* of our working force engaged in science, engineering, and medicine as we have today. Maybe it will be 30 years. But the trend is in this direction, and the task will be a gigantic one. We had better explore the possibilities.

Sources of Supply

Short-range problems (that is, up to 4 years hence). Our most immediate, and indeed our only existing, source of supply of engineering talent consists of those already trained and at work in the field—our present reservoir. There are some 600,000 men and women in this reservoir, and one might say that there is nothing we can do to increase it. But there is. If we could improve the efficiency of utilization of these 600,000 people by only 5 percent this year, we would thereby add to the effective engineering force as much as all the new graduates of the class of 1956.

Can such a thing be done? I think it can. Let us consider some sources of inefficiency.

In the first place, since shrewd foresight is a great American virtue, it is natural for every industrial manager to save a few dollars for a rainy day, and also a few tons of steel, or copper, or aluminum, or oil, or whatever he might need. Why not at the same time stash away a few engineers too? They will come in handy if that next big contract comes through. And besides, they can be put on the payroll of the other Government contracts in the meantime and so it doesn't cost the company a dime to hang on to them!

How much of this goes on, if any? No one can prove a thing. But many an employed engineer will tell you that this is happening. Besides, it is not illegal and

is, indeed, just ordinary business judgment—just a good example of that old-fashioned virtue of thrift. And this habit of thrift is probably a very difficult habit to eradicate. I do not even think of any "gimmick" that would eradicate it—in fact, most proposed remedies only make things worse and would penalize those who do not hoard. (Thrift, of course, is what *you* practice; hoarding is what the other fellow does!)

As with other problems, only a program of education and propaganda can help—possibly with contract penalties for unreasonable hoarding practices.

But there is gold in these hills of more effective utilization of engineers. Companies that have to pay for their own engineers learn to use them effectively. And I will wager that in any sizable company the engineers themselves could propose ways of reducing the staff, or at least of not increasing it. The Government contract officers could, no doubt, exert very strong influence for more efficient utilization, but this is a risky procedure.

Many engineers complain that companies often fail to recognize the difference between engineers and draftsmen. As a result, the desks of hundreds of engineers are jammed side by side in warehouse-type buildings amid all the clutter and clatter of typewriters, computing machines, and jangling telephones. It has been pointed out that to provide each engineer with his own small office would cost less than 1 year's salary, and it would improve his output, and that of his successors, for a score of years or more. We must never forget that the kind of engineering we are short of is not routine drafting but is hard, original intellectual effort—the kind of thinking that is elicited most fully only under the best of physical conditions.

Industry, however, is not the sole culprit. The Government too must take a great deal of blame for a low utilization factor for scientists and engineers. Inefficiency and incompetent leadership in its own laboratories, the conflict between military and civilian direction, red tape, lack of prompt decisions, are all frustrating barriers to effective work.

Furthermore, in its planning of the military-weapons program the Government is guilty of gross waste. Interservice rivalries and consequent duplication, the obsolete and cumbersome methods of making critical decisions and choices between rival enterprises or devices, the lack of any machinery for stopping any project that is under way—all these things require ten engineers to do the work of eight, or fewer.

I believe a very thorough and far-reaching change in the decision-making apparatus of the Defense Department in research, development, engineering, and production matters is called for if we are to eliminate a degree of waste that threatens to keep us perpetually short of technical talent.

I think I have said enough to illustrate the point: If we could utilize our present engineering talent more effectively, our shortage could be substantially reduced. But this will take strenuous, far-reaching, and intelligent efforts by government and industry.

However, this is the only way in which a short-range alleviation of our problem can be approached. It takes 4 years or more to educate an engineer. The number of engineers who will graduate 4 years from now—in 1960—is now fixed by the number who have already registered as freshmen for next fall. A certain percentage of these will fail or drop out; a few will swing from other fields into engineering and science. A good many freshmen who have not made up their minds can still be influenced. But, although I believe we should exert all efforts to improve our teaching and counseling and enhance our persuasiveness, these will have but relatively small effects for the coming 4 years.

Long-range problems (greater than 4 years). It is at the level of the high school—and possibly even more in the sixth to eighth grades—that the really important increases in future supply of trained technical talent is to be found. Of even the intellectually competent sixth-graders, 17 percent will not finish high school; 60 percent will not enter college; 70 percent will not finish college. Why?

Here we strike at the heart of our national problem. Why do not able young people go to college? Why do they not prepare themselves in larger numbers for science and engineering courses?

There are many, many reasons; and, in fact, for each individual child there is a unique set of factors that determine his decisions—factors made up of home environment; economic and social position; influences of parents, teachers, relatives, and friends; the atmosphere of the school; the skill of the counselors, if any; the quality of instruction; reading habits, and so forth. It is a striking fact that a very large percentage of the freshmen who do enter college trace their decision to a teacher or parent or friend who recognized their talent and encouraged its development. But think how many have gone unrecognized, undiscovered, and hence undeveloped—if not positively frustrated!

There has recently been organized in Oklahoma City a "Frontiers of Science Foundation" composed principally of business and professional men whose aim is to mobilize a state-wide—and eventually a nation-wide—effort aimed at the junior-high-school student, his parents and his teachers, to bring home the needs, the opportunities, the requirements, and the rewards of a scientific or engineering career. Traveling exhibits, movies, newspaper stories, public and private talks are being arranged. As a result of well-informed efforts, a real awakening is occurring in Oklahoma to the fact that science—pure and applied—furnishes the challenging frontiers of the future. I hope that the Oklahoma efforts will become national. Let us enumerate some of the things required for a nation-wide awakening of this sort.

1) Junior-high-school teachers in all subjects, especially mathematics and science, must be given more support and more rewards. They need higher salaries and better community recognition; they also need teaching aids (movies, laboratory equipment, and much more stimulating textbooks).

2) Counselors of young students need reeducation. Only too often students are advised away from science because it is said to be too technical, too vocational, or just too hard. "Return to the liberal arts," they say, "and make the world a better place to live. Scientists are just technicians and makers of terrible weapons." An astonishing amount of such nonsense is handed around. Science as one of the liberal arts—as a necessary part of every liberal education—has been overlooked. Mathematics—an essential language of communication in the modern world—has been allowed to degenerate into endless routine solutions of meaningless problems.

3) Parents of children—and this means men and women in all walks of life—must be brought in touch with the frontiers of science through newspapers, radio, television, magazines. They must get a glimpse of the values, the thrills, the rewards, the opportunities, in careers in science and engineering. They must see that their children are tested for their aptitudes and then encouraged and stimulated if they have mathematical or technical talents.

4) The scientist and engineer should be presented to the whole community in his true light—not as the absent-minded professor intent on blowing up the world; not as the cold-blooded technician who would be glad to see his machines crush men into extinction; not as the man who, if allowed to gain control, will lead civilization into soulless decay and physical destruction. Why not, instead, present the scientists and engineers as the men who have lifted civilization from dark-age feudalism and slavery to 20th-century liberty and enlightenment? It was knowledge of nature's laws that abolished the fear of demons; it was the steam engine that ended slavery; it was the power machine that gave men freedom from endless hunger-driven toil, and thus made all other freedoms possible and meaningful. The scientist and engineer, as human

beings and as benefactors of the race, must be brought to the people and to the schoolroom—in person!

5) These measures will help to motivate and encourage students of talent. But how do we discover the talent in the first place? We do not know! A competent and comprehensive program of research should at once be begun—or enlarged if already started—aimed at developing more satisfactory ways of discovering aptitudes in young people. Mathematical aptitudes are especially important. They are sufficiently specific to be detectable at an early age. When such aptitude-measuring techniques are developed, they should be used on a nation-wide scale to discover every youngster with potential technical abilities. We have spent hundreds of millions of dollars to search out and develop our resources of uranium. Are our nation's brains of less importance? Or was it brains that made uranium important?

6) We must find more cogent inducements to persuade boys and girls of talent to enter the study of mathematics and science, to prepare themselves for careers. Local and national college scholarship programs are excellent, but often do not reach down to the eighth or ninth grades. Contests, prizes, awards, science fairs, exhibits—maybe even comics and TV programs—could help. But the critical need is for more and better teachers.

7) Finally, we must recall that we have almost completely failed in the physical sciences and engineering to make use of the talents and services of women. Psychologists tell us that there is, statistically, no essential difference between the kind of mental aptitudes found in men and in women. Why are there not just as many female engineers as male, thus doubling our potential supply? Why indeed? There are some good reasons involving homemaking, motherhood, and the social custom that requires little girls to play with dolls instead of electric trains. But these reasons are not enough. Millions of women do work in spite of home duties and motherhood; indeed they work so that they can have better homes and more children. Junior science fairs have uncovered some very able girl scientists. Why not a nation-wide effort to attract girls into technical interests?

Tasks of Higher Education

I have said that the number of engineers we will produce each year until 1960 is already largely determined by the numbers now enrolled in our colleges and universities, and is not likely to be significantly changed. But this does not imply that our institutions of higher education do not have some important tasks to perform. The *quality* of the future scientist and engineer will be determined very largely by what the colleges do.

I must first emphasize, however, that we have been talking about *the* scientist or *the* engineer as though he were but one kind of person. Actually, scientists and engineers are of many types. Not only are they divided—horizontally, we might say—into the many subject-matter fields of specialization, but they are also divided vertically into a wide spectrum of different types or qualities. These different types range all the way from the trained laboratory assistant at one end to the most highly original and imaginative genius—the Albert Einstein, so to speak —at the other. The different segments of this spectrum are not always separated solely by differing degrees of intellectual capacity; they reflect also different qualities of interest, taste, and personality as well as combinations with other talents such as administrative ability, "sales" ability, speaking ability, or even physical strength.

There is a place for many types and combinations of talent and training. The competent assistant or technician is indispensable to modern research and development. So also is the competent "team research" man or the member of an engineering staff. So also is the sales engineer, the engineering supervisor, the laboratory director, the lone original research worker or designer, the skilled computer, the mathematical scientist, the patient systematic observer, the skilled synthesizer, the able teacher or lecturer or writer, and a host of others. We need men to penetrate the mysteries of nuclear forces and men to build dams and roads; men to learn the secrets of the stars and the structure of viruses; men to discover the nature of the chemical bond and men to make better steel; men to study cancer cells and men to dig oil wells; men to design skyscrapers and other men to air-condition them; men to keep the intricate machinery of transport and communication in operation; men to direct great enterprises of research, engineering, construction, and manufacturing.

Now obviously this is a big job for universities; maybe an impossible one. How are they going to turn out such a bewildering variety of specially trained people? They cannot, of course—and they should not even try. What they should do is to recognize that any particular student now enrolled might some day end up in any one of a dozen different kinds of jobs, even though he remains in the same subject-matter field. Hence, paradoxically, because a man will later specialize, the courses he takes in college should *not* be too specialized. Rather, they should provide a broad base from which the student can proceed in any one of many directions. A broad curriculum of studies in basic principles of science is called for, plus adequate experience in nontechnical fields such as the humanities and social sciences. There must be opportunities to explore new fields and to alter one's course in the light of newly discovered interests and talents.

All of these things the better schools of engineering and science try to do, but they could all do much better.

I think, too, that colleges and universities should face more frankly the range of intellectual caliber to be found among their students and the level to which each institution wishes to cater. At present no college dares to admit—even to itself—that it is going to cater to the middle or lower third of college students rather than the upper third. Each institution strives to get as many of the top 10 percent as it possibly can and then reluctantly goes down the list, admitting as many as it needs of the lower groups in order to fill the class. Naturally, some colleges have to hit the bottom of the barrel, particularly the state institutions that are required by law to admit all applicants with high-school diplomas.

As a result, most colleges will get a few top students, but the average level of ability will differ enormously from one institution to another. Of the top 25 percent of some college classes, only a small fraction would be even admitted to other colleges. Yet no institution has yet publicly advertised that it will accept only middle- or low-grade students, will design its curriculum for them, and will encourage all other students, both those below and those above certain limits, to go elsewhere. But why not? We do not entice a potential all-American fullback to come to Caltech on the assumption that he can get as good athletic experience and training there as he can at Notre Dame. Why does a college pretend it can serve all levels of intellectual ability? This is a good question!

Actually, the students themselves are not quite as dumb as we think. I understand that more than half of the 300 or so top men students of the country who won National Merit Scholarships chose to go to only a half-dozen institutions, all of which are generally recognized as being the most difficult in the country to enter. Those boys were smart enough to know that if they were smart enough to win a scholarship, they ought to go where the smartest students are to be found. Yet some people complain that this is being "unfair" to the smaller and less famous colleges. But I say it is unfair to the other 50 percent of those smart boys if they go to institutions where they will never have the competition required to develop their talents. If I did not mind risking my academic neck, I might even seriously suggest that the Merit Scholarship Board should not allow any of the winners in the top 1 percent of the country's youth

to use their scholarship at any except a select few of the institutions of the country that have the proved capacity to give full challenge to top talent.

But if this is an impractical suggestion I can at least urge, first, that every able student find out for himself which institutions can offer him the greatest challenge, and, second, that every college give especial attention and encouragement to those exceptionally gifted young people who do attend.

And this leads directly to the heart of the most important of all problems facing us in this country: the improvement in quality of education. Improvement of quality is necessary in all fields—business, law, politics, government service. But especially in scientific and engineering work is quality of education of prime importance. In the field of manual labor, if one man cannot lift a stone, possibly two or three men can, or a machine can be found to do it. But in the scientific or engineering field it is not assured that if one man cannot solve a problem then two or three or more can solve it. And certainly no machine will of itself do it. The law of addition or multiplication of forces does not hold in the intellectual field. A single Einstein may accomplish a solution which a thousand lesser men could never attain. In the Manhattan District Project during World War II, 1000 scientists and engineers were needed to complete the task in time. But the towering talents of a relatively few men like Fermi, Bethe, Wigner, Oppenheimer, and a dozen others were decisive in setting the pace of the effort. Fermi needed many men to help him in his pioneering experiments. But the other men alone, even though their number had been doubled or trebled, might not have obtained the answers. Creative ideas, in other words, occur in the minds of single individuals. Hence, the pace of progress is determined by the quality of individuals rather than their numbers, and when quality is sacrificed for numbers we may get weaker rather than stronger.

I do not wish to imply that quality can always be improved by reducing numbers. Plenty of very large universities have produced scores or hundreds of men of distinction, and plenty of small colleges have never turned out one. The goals of quality and quantity are separable; under proper conditions both or either may be obtained. But we do not attain either one if our whole attention is given to the other.

In short, while we expand our efforts to see that every competent boy and girl in America—every single one—has the full opportunity to develop his talents, we must not at the same time give up the goal of improving the quality of our educational system all along the line. We can address ourselves to both tasks. They are not necessarily mutually exclusive. Nevertheless, there are certain practical limitations to the rapid achievement of the double goal. The practical limitations are—as in most problems—of two kinds: money and people.

It is possible to double the classroom space of a school and also to improve the quality of instruction. But it costs more and takes more good teachers. Therefore, we are frequently tempted to build the classrooms and neglect the teachers.

We dare not neglect either the qualitative or the quantitative problem. Yet we are often unable to solve them both at once. I can offer no simple formula that will resolve the dilemma. I can only emphasize that both quality and quantity are important and that while many others are crying for more engineers I would like to enter a plea also for better ones.

What does it take to get better ones? It takes, first all, the things that I have been talking about: better public schools, better teachers, better counseling, better testing and selection, better opportunities for study of mathematics and science, improved attention to the gifted student. At the college and university level, it means similar things—improvement in quality all along the line.

In particular, however, I think it is important that a few institutes or schools of science and engineering be encouraged to devote their resources to the sole task of improving quality without trying to grow in size. If, for example, a dozen top institutions could obtain enough additional annual income to bring their faculty salaries to a level where the flow of top young people away from teaching could be stopped, the country would be repaid many times over.

I do not pretend that this would be a popular suggestion, or even a possible one. Certainly I should not want the task of choosing the institutions. Only a private foundation could face up to that task. And, although the $10 million a year that might be required is small for the country as a whole, it is an enormous sum for any single foundation In terms of endowment, for example, it would involve another gift the size of the recent Ford Foundation gift to colleges ($250 million), but this time divided among a dozen or 15, instead of more than 600, institutions.

Advanced Training

The need for improved quality of engineers is a need for engineers who are more creative—that is, for men with the ability and training to pursue new ventures, to develop new ideas or techniques or equipment, to participate in research and development programs. In the field of science it is now taken for granted that either a master's or a doctor's degree is a prerequisite for a career in the field. It is widely assumed, however, that 4 years' training is adequate for an engineer. There is, indeed, a large field for the 4-year graduate; but if the top 25 percent, say, of the engineering graduates could be encouraged to go on to an advanced degree, with possibly 10 percent of them pursuing the doctoral degree, the quality of the nation's research and development effort could be substantially improved. The quality would be improved, first, because the graduate schools would admit only those selected men who by temperament, ability, and previous training are competent to pursue creative activities, and would then give these men experience with the frontiers of engineering and with the techniques of creative work. It is, for example, especially important that we have more engineers of exceptional ability in theoretical work. In aerodynamics, hydrodynamics, mechanics, structures, materials, and other fields, there are tremendous opportunities for the man with sound and extensive mathematical training and with experience in theoretical research. We are realizing more and more that advanced engineering development consists of not only the invention of gadgets but also the solution of highly complex mathematical and theoretical problems. Only extended graduate training can produce the men required.

Therefore, I propose that the nation give more extensive attention to the selection of engineers for graduate work, to the building up of graduate work and research in schools and institutes of engineering and technology, and to the more adequate support for creative engineering research in these graduate schools of engineering. There are many serious problems that impede such an effort.

First, there is the financial problem facing the individual student. When a young bachelor's-degree graduate in engineering can go immediately into a job that pays him between $400 and $500 a month, he must be confronted with powerful counter arguments to persuade him to decline such offers and to continue his educational career. There are several things that can be done to provide such inducements. Industries themselves can stress the importance of advanced training for those who are competent to profit by it. Both industry and government can provide additional fellowship funds to assist in reducing the economic barriers to advanced graduate work. There are also possibilities in developing programs of part-time employment in industry for those who are carrying on graduate work.

I should like to emphasize, however, the dangers of this latter course. Graduate work, to be valuable in developing

creative engineers, is not the type of training that can be provided by attending three classes a week—possibly in the evening hours—and working at a regular job the rest of the time. Research work is not a series of college courses; it is a way of life. And I do not believe that either a scientist or an engineer can become fully qualified for research and development work unless he has actually lived full time in the atmosphere of a graduate institution, fully immersed in some phase of its research program. It is quite possible, of course, for a man to have an industrial job during the summer months and it is also quite feasible, if commuting distances are not too great, to work at a job 10 or 15 hours a week and still carry on a normal full-time graduate program. Nevertheless, it should be recognized that every hour spent away from the campus, from the classroom, the library, or the research laboratory is something to be avoided if possible, for it detracts from the full-time devotion to the life of research—a life that must include time for reflection and study.

Therefore, I should like to urge universities to use their influence to stem the spread of so-called "cooperative programs" in which it is assumed that graduate work and training for research can be achieved in only a few hours a week spent in a university classroom, while the student is carrying on a nearly full-time job. At the same time, I would urge industry to develop methods of expanding their fellowship programs and other ways of making it possible for their employees to spend full time on their graduate work and still receive adequate stipends.

Another barrier to the expansion and improvement in quality of graduate work in engineering is, of course, the matter of teaching. First-class creative engineers, who are the only ones who can supervise first-class graduate study, are in great demand in industry at salaries that are, quite normally, at least double the salaries available in even the best paid university faculties. Here, therefore, I must repeat the suggestion I made a short time ago that a few schools of engineering in the country which already have good graduate schools be given adequate support to increase the salaries of their key people by 40 to 75 percent in order to keep and attract the top-notch engineers required for an adequate graduate program.

These then are a few of the things that should be done to improve both the quality and quantity of our engineering and scientific manpower. Much of my argument can be summed up by saying that we ought to take our capitalistic system more seriously; we ought to offer larger rewards to those doing the most important jobs. Fifty thousand dollars does not make a good engineer; but it may prevent a good one from being diverted to other pursuits.

Factors Limiting Higher Vertebrate Populations

Paul L. Errington

At times, in seeking to generalize, a student of animal populations may feel that almost anything can and does happen or that the one common propensity of animals is to live if they can and die if they must. Nevertheless, some patterns are coming to stand out in the population dynamics of many species of animals.

My own studies of such patterns have dealt with what are commonly thought of as limiting factors in mammal and bird populations, and, in this connection, I have observed that important aspects of competition and predation may be particularly misleading if certain natural relationships and adjustments are not adequately taken into consideration. The following discussions will therefore present some of my ideas of distinctions that are worth keeping in mind when one attempts to analyze effects of competition and predation on population in at least mammals and birds (*1*).

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Competition and Habitat Selection

There may be circumstantial evidence seeming to link changes in distribution or abundance of animals with changed intensity of competition. Of two closely related or closely associated species, one gains as the other fades. But, is one species displacing the other or "competing it out," as through greater aggressiveness, or are both merely responding to such habitat changes as are favorable or unfavorable to one or the other?

We do know that ascendancies and declines of bobwhite quail and of certain species of grouse have accompanied different stages of human settlement in the north-central United States, and we know that, for the grouse—pinnated, sharp-tailed, ruffed, and spruce grouse—the habitats of one species grade off into habitats of the next species ecologically in line. Yet the segregation of these native gallinaceous birds into their own niches is not so complete that it rules out possibilities of tension zones where one species could well have a depressive influence on populations of another. In cases marked neither by overt antagonisms nor by destructive impacts of one species upon the other's food supply or general environment, evidences may be seen of differential mortality or of withdrawals of one species into poorer habitats. But, again, in so many cases of what *could* be significant interspecific competition, we must return to such questions as: How much may the observed phenomena be due to something else—for example, to responsiveness to habitat niches?

The distinguishing features of habitat niches for a species are often too elusive for human perception. The main criterion for judgment may be the behavior of the species, itself, considered over sufficiently long periods of time to be meaningful. Svärdson (*2*), writing of competition and habitat selection in Swedish birds, describes the establishment of wood-warbler breeding territories at the same places but by different individual male warblers each spring. Despite local differences in topography, vegetation, and light conditions, selection of the old territorial sites by newly arrived, strange birds proceeds according to pattern each year. After very intensive studies, McCabe and Blanchard (*3*) concluded that the three species of California deer mice with which they worked have

an extreme sense of environmental specificity, which serves to keep members of each species segregated into niches.

It could be contended, I suppose, that it would be a peculiar animal that did not recognize its proper habitat when it found it, irrespective of the numerous examples that might be listed of animals pioneering into new habitats or otherwise trying to live somehow even when they find themselves outside of anything resembling a proper habitat. The gradations in suitability that habitat niches may show for their occupants may, however, lead one to ask just when enough is enough, when marginal habitability becomes submarginal or worse. Svärdson's studies of competition emphasize the tendency for strong *interspecific* competition or population pressure to cause a species to retreat to those habitats in which it is particularly adapted to maintain itself. Conversely, strong *intraspecific* pressure may force the species into a much greater variety of habitats, including those that may scarcely be defined as habitable for the species trying to live in them.

Of course, if we look for examples of animals either living in very restricted niches or showing spectacular mass increases or invasions or colonizations of new habitats, we can find them all the way down the phylogenetic scale from mammals and birds. We need only consult the vast entomological literature. Or, we can go down toward that nebulous line of demarcation between what is living and what is nonliving.

I have worked on the epizootiology of what can be an extremely contagious and deadly hemorrhagic disease of muskrats. The full etiology of this disease, in my opinion, remains undemonstrated; but, whether the available evidence suggests a viral or a bacterial agency, or a combination of them, or something else, the manifestations of the disease in our Iowa study areas are all but restricted most of the time to certain special tracts of marsh or stream. In thinking over the long-term case histories of these foci of infection, I keep comparing them with our case histories of strategic habitats for the muskrats themselves, or with strategic habitats for bobwhites, pheasants, horned owls, minks, rabbits, foxes, and other higher vertebrates, or with those kinds of strategic habitats that Uvarov (*4*) and later authors call areas of permanent occupation for grasshoppers and locusts.

When we look for further parallels between population behavior of the muskrat disease, of the muskrats, of the bobwhites, the pheasants, the grasshoppers, we may often find them if we consider overflows from strategic habitats. The muskrat disease, if it spreads from a focus of infection into an adjacent part of a marsh having a dense contiguous population of the host animals, may virtually depopulate a large tract of its muskrats in a few weeks; but, when the dying subsides and the depopulated tract begins to draw in newcomers, about the only places where we may expect renewed flaring-up of the disease will usually be at or near the old foci of infection. At the risk of minor inaccuracies, we may say that the contagion seems to withdraw into its own areas of permanent occupation—at any rate, to these places that retain sufficient infectiousness over the years to be reservoirs.

When many animals overflow their strategic habitats, it may be only into places nearby or into places perhaps not differing greatly from the strategic habitats, or it may be into strange and inhospitable places. Muskrats of overpopulated desert marshes may engage in fatal movements into the surrounding desert in ways reminiscent of the famous migrations of Scandinavian lemmings into the sea. Overflows of muskrats often may be not very dissimilar to the overflowing of certain grasshoppers and locusts from their breeding grounds, the special aspects of the latter movements notwithstanding (*5*). Pepper (*6*), in comparing thresholds of security and associated phenomena shown by our Iowa muskrats with what he had been seeing in Montana grasshoppers, brought out similarities that look very suggestive of common denominators in the population behavior of even such distantly related forms.

The main point that I would make here is that, whether a species is intrenched in the best of habitats or is trying to live where it really does not belong, whether it is highly versatile or has the most specialized of adaptations, the role of competition in its population dynamics may still be more difficult to appraise than may at first be apparent. To distinguish between cause-and-effect relationships and the merely incidental may require, for one thing, less emphasis upon what seems obvious and more emphasis upon trends indirectly suggested by long-term data.

Let us, for the time being, go on to other subject matter notable for the ease with which it may be misappraised.

Predation and Territoriality

Predation may have its superficial simplicities. It may look as simple as one animal killing and eating another animal. When the victim is dead, it is dead, and the species to which it belongs has one less living individual. From here, it is possible to make many speculations about the effects of predation on population, especially on the theme of how high the population levels of prey species would go were it not for predators preying upon them. It is frequently assumed that a predatory species exerts a limiting influence on a prey population about in proportion to the number of prey individuals it kills.

Predation, assuredly, *can* depress a prey population. Under special conditions, the impacts of a predator on its prey can be so severe that whole populations of a vulnerable prey species are wiped out. Predatory man has demonstrated this over and over again. On the other hand, the accrued evidence indicates that much predation may operate in an incidental fashion rather than as a true population depressant (*7*). The distinction to be kept in mind is that predation centering on essentially doomed surpluses or wastage parts of prey populations is in a different category from predation that cuts right into a prey population and results in the prey's reaching or maintaining a significantly lower level than it would if it did not suffer such predation.

In analyses of the population dynamics of animals, we must not ignore the role of social intolerance as a limiting factor. Social intolerance may or may not be tied up with food supply or other of the more obvious needs of a population at a given time. The more dominant types of intolerance include those that we think of as territorial, even when habitat resources may appear to be only slightly utilized by the individuals claiming possession.

Territoriality is variously defined in the literature, but the definition of a territory as any defended area is one of the most acceptable (*8*). In its manifestations, territoriality varies greatly with the species and the circumstances. It is not lacking among invertebrates and lower vertebrates, although, in those groups, its intensity may be weak, or we may have to strain a bit to apply the label of territoriality to certain intolerances. Nor are the more pronounced forms of territoriality to be perceived among all higher vertebrates. Still, the higher vertebrates include the most patently territorial groups of animals and those patently the most nearly self-limiting.

Self-limitation is about what strong territoriality adds up to in population dynamics. It allows *Lebensraum* for about so many animals of one or, sometimes, a combination of species at a given time and place. Compared with the basic role of territoriality in the population of many higher vertebrates, predation enters in as a secondary phenomenon and as one having, in more instances than are usually recognized, slight if any real depressive influence on prey populations—even when the predation may be severe in terms of numbers or proportions of the prey species killed by predators.

When a strongly territorial species fills

up its habitat as much as the species will itself tolerate, and the surplus individuals cannot live anywhere else, the species may maintain its numbers with a high degree of independence of variations in kinds and numbers of predatory enemies. The muskrat in the north-central United States illustrates this sort of relationship, and we may see, for this species, that a great deal of the frequently conspicuous and severe interspecific predation does not really count (*7*).

If surplus individuals excluded from the better territorial sites can live in the less attractive places in the absence of but not in the presence of certain predatory enemies, the resulting predation may operate to some extent as a population depressant in the inferior habitats. This situation may be not uncommon when the prey species is one showing versatile behavior.

Some higher vertebrates may be sufficiently tolerant of crowding to increase up to the limits of their food supply in the absence of significant predation. North American deer are among the better known examples (*9*), but, on the basis of careful work on California deer herds (*10*), it would appear that the deer population is primarily determined by quality of habitat and that predators do little more than to remove the annual surplus. In many areas, striking increases in numbers of deer have been correlated with artificial reduction of the more efficient deer-killing predators. The deer populations have then built up to temporary levels above the carrying capacity of the land, with biological repercussions coming later, as from starvation or damage to the habitat. While territoriality exists for the deer and represents, for them, a self-limiting tendency, it does not limit enough to leave deer populations in quite the same category of independence from influence by predation that follows, for example, from the stronger self-limitation of the north-central muskrats.

It is quite to be expected that some animal species will show greater tendencies toward overpopulation, overuse of resources followed by population collapses, and, on occasion, by net depressions of population levels through predation, than do our more strictly self-limited species. The less that strong territoriality or other self-limitation enters population equations, the more something else must do the limiting.

Competition, Predation, Compensations, and Models

The quest for generalities in the population behavior of organisms has led to a substantial amount of laboratory experimentation (*11*). Oversimplifications and artificialities need not detract very much from the interest and value of these experiments as long as the experimental results are not misapplied to relationships that are far more complex. In working with field problems, we may think of the better conceived laboratory experiments with populations as suggesting rules of order that we ought to know something about before we go on to consider the interplays, interruptions, deflections, and successions that characterize free-living populations.

Based either on experimentation or on purely theoretical grounds, many efforts have been made to express population relationships mathematically. I make no pretense of being able to examine the resulting mathematical treatments with any notable competence, but I have recognized that those of Nicholson (*12*) and Cole (*13*) seem to come the closest to depicting relationships that I, personally, have observed in nature—particularly the mathematical expressions of thresholds of security, overflows from favorable into unfavorable habitats, and compensatory trends.

Ideally, perhaps, everything that happens should be expressible mathematically, but, in the matter of population equations, I would say that the mathematicians have some distance to go. They have an imposing array of analytic pitfalls to avoid, and some of my mathematician friends confess that they do not see how anyone is ever going to put down on paper true-to-life mathematical expressions of the sorts of population relationships that are commonplace among higher vertebrates. But the potentialities of mathematics as an analytic tool in population studies should be far from exhausted at the present time. What I am stating here is not intended to discourage mathematicians from going ahead with any promising approaches that they might have. My purpose is only to emphasize that, to be true to life, the mathematical expression of a population equation must not assume constancies that are not constant or more randomness than exists, and that it must not fail to take into minimal account the capacities for adjustments that living species have acquired during the millions of years that they have lived their lives in their own ways.

Elton's (*14*) essay on animal community patterns emphasizes the grouping of populations around centers, in contrast to mathematical theories that treat populations as if they are randomly interspersed over major areas. Differences in soil types, warmth, moisture, plant successions, the location of a carcass or a rotten log, the segregation into habitat niches, and so forth, may leave scant uniformity in the natural distribution of a species and thus reduce the prospects for finding true-to-life formulas that apply to the more complex situations.

Let us consider the way in which the hemorrhagic disease may kill muskrats on a marsh when the muskrats are so few in number as to be barely present and when, according to some mathematical models, we should hardly expect continued dying. In nature, we can have the *entire* local population dying and newcomers dying about as fast as they come in. The reasons for these high mortality rates at times of very low over-all population densities on the marsh are, in their gross aspects, quite plain—they chiefly reflect the fact that the deadlier foci of infection may also be among the more attractive places for muskrats on a marsh. The more that perfectly normal newcomers pick out and rehabilitate deadly burrow systems, the more die there, and the deadlier the burrow systems become over the years, until certain tracts of marsh may become all but uninhabitable for muskrats for years at a stretch. Under these circumstances, I cannot see that so very much of randomness is left in the population equations of either the hemorrhagic disease or its muskrat hosts.

Some remarkably definite patterns are shown by case histories of free-living wild populations, but it can be tricky to represent these in mathematical formulas. There can be much compensating in a population equation, or, in other words, automatic letting out and taking up of slack. Granted that many species can be sensitive to environmental changes of slight amplitude, we do have many populations maintained for long periods of time at notably uniform levels, more or less irrespective of a great many variations in breeding and mortality rates and in the weather, food supply, and other of what we consider ordinary environmental factors (*7, 15*).

The modern work with higher vertebrates perhaps illustrates as well as any how compensations operate, and, in order to remain within the philosophic bounds of personal familiarity, I shall draw my concluding examples from the results of our investigations of Iowa muskrats (*16*). We find in our data on muskrats plenty of evidence of conformity to patterns that are definite enough to be expressible by segments of sigmoid curves (*17*), but which mean balancing and counterbalancing in population equations. The classical Darwinian view of the balance of nature is misleading with reference to population dynamics of the muskrat because it is so apt to put nature's resiliences and rigidities in the wrong places.

Instead of a population equation in

which the end product varies directly and matter-of-factly and in an aboveboard manner according to variations in reproductive and mortality rates, we have end products that often look more or less predetermined. The latter may be a postbreeding population of around 400 muskrats on a 270-acre marsh, or 9000 muskrats on 1000 acres elsewhere, or some other comparatively definite number for another area. Or, when populations are well below saturation levels for an area, the annual rates of gain may conform to a sliding scale of values. When the end products of population equations show pronounced tendencies toward stability or conformation to patterns, the other parts of the equations are necessarily the parts in which adjustments occur whenever changes in reproductive or mortality rates would tend to disturb equilibria.

Although larger or smaller proportions of young muskrats may die from the attentions of predatory enemies or from weather vicissitudes or from attacks of other muskrats in one year than in another year, the population consequences of specific mortality factors seldom carry through long enough to affect appreciably the end products of our population equations. This, in particular, represents a departure from the Darwinian view. Instead of every agency of mortality each depressing the end product in proportion to the number of animals it kills, we have a lot of nullification of what we conventionally regard as limiting factors. Not only do we have natural substituting of one factor for another, but mortality may also precipitate natural population responses that tend to offset it.

Let us consider mink predation and the way it fits into our equations for muskrats insofar as this has been most intensively studied on a long-term basis (*18*). Minks and muskrats may be closely associated in North American wetlands, and the minks are enterprising and able hunters that kill and eat muskrats about wherever they can. In some regions, they kill more muskrats than all other nonhuman predators combined. But, in analysis, mink predation on muskrats of the north-central United States turns out to be virtually centered on overproduced young muskrats, upon ailing and battered individuals of all ages, and upon those generally comprising the wastage animals of a population. The victims need not be manifestly unfit. Insecurity of position can impose as deadly a handicap on an animal in normal physical condition as can the sluggishness or weakness of an animal that is physically subnormal.

Particularly worth emphasizing in appraisals of net population effects of agencies of mortality is the evidence that the broad categories of muskrats most likely to be preyed upon by predatory vertebrates—excluding man—have poor life expectancies, anyway. They are the likeliest candidates for elimination through one agency or another, whether the minks are abundant, scarce, or absent, or whether the other common muskrat predators are abundant, scarce, or absent. In the frittering away of doomed surpluses, or of parts of populations doomed because of emergencies, it seems to make so little difference in the end what the specific agencies of mortality may be that I rarely feel sure of the logical propriety of ascribing true depressive influence to any one agency. Of what demonstrable population significance is any agency of mortality as long as much the same patterns in population trends continue to show up, seemingly irrespective of whether that agency operates or not?

If the effects of an agency are severe enough—if a deadly epizootic, a hurricane, or a drouth brings about a cataclysm for the muskrats over an immense area—the mortality can be sufficient to depress a population, but there still may be compensation. One of the commonest ways by which extraordinary losses are offset naturally is by accelerated reproduction.

The reproductive activities of our Iowa muskrats have an obviously close connection with psychological changes. Adult females giving birth to their usual maxima of four litters during a breeding season are typically animals living at low-to-moderate densities in a strong environment or those losing large proportions of their early-born young. On the other hand, those subject to the damping effects of crowding past their toleration limits just quit breeding early in the season after giving birth to a litter or two. As long as relief from the inhibiting effects of overcrowding remains such a stimulus to prolonged, late-season breeding—as long as heavy mortality among the early-born young, or special success of the early-born in keeping out of the way of intolerant elders, or the chance underpopulation of habitats may result in doubling the number born per adult female—the need for allowing for compensations in our pencil-and-paper figuring would not appear to be trifling. As long as the end product of a population equation remains unchanged, with reproductive and mortality rates serving as functions of each other in the ways indicated, more reproduction means more mortality, and vice versa.

In short, throughout any true-to-life equation representing population dynamics of the muskrat, there should be compensation after compensation, although it does not follow that all of the adjustments involved must be completely compensatory. Perhaps few of them are completely compensatory, but neither does it follow, if any one agency kills half of the muskrats during the breeding and rearing months, that relief from that agency will double the number of muskrats alive after the breeding and rearing months, nor does it follow that the appearance of a new and deadly agency that kills half of the muskrats must thereby reduce the end product of a population equation by half.

Solomon (*15*), in his review paper on natural control of animal populations, refers to the compensation principle as being of general applicability. This has not only been discussed in regard to vertebrate populations (*7*), but Nicholson and H. S. Smith, the entomologists, also have been expressing similar views for many years. In the literature on population, the idea of populations' being to some extent self-controlled is therefore nothing wholly new. Still, the singular importance of considering automatic and compensatory adjustments in population dynamics is far too often neglected even in scholarly thinking, and a realistic approach in population studies calls for more attention to things that do not always work out with the inexorable precision that data tabulations might seem to imply.

References and Notes

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A. J. Kluyver, Microbiologist

During the night of 13 May 1956, Albert Jan Kluyver, director of the Institute of General and Applied Microbiology at the Technological University of Delft, Holland, died at his home of a heart attack at the age of nearly 68 years. Those who have had the privilege of knowing him, personally or merely through his work, realize that his death is a great loss to humanity.

Kluyver was admired by his acquaintances, and his associates were devoted to him, for he possessed a rare combination of personal and scientific attributes that charmed even the most casual visitor. A more prolonged association with this noble personality inevitably stimulated the desire to cultivate similar traits. Thus he generated benevolence by being a living example of it—veritably, the only way in which a lasting influence can ever be produced.

Endowed with a strong sense of responsibility, Kluyver accepted the appointment of the chair that had been vacated by M. W. Beijerinck in 1921, with the clear recognition that his was to be a difficult task. Through unremitting application, he hoped to justify the confidence placed in him by the authorities. This attitude caused him to lead a life of incessant study, up to the very end, which also accounts in part for his great achievements.

His critical approach, often expressed in gently ironical form, his enthusiasm, compassionate nature, and deep understanding of human behavior were responsible for the warm, inspired atmosphere and for that spirit of generous and effective collaboration in his institute that has impressed visitors and students alike. Hence, the laboratory was always occupied by eager workers until midnight and later. Add to this Kluyver's mastery of words and his insistence on perfection, and the characteristics of the superb educator that he was will become apparent.

In this atmosphere originated the many contributions for which he has become justly famous. In an early survey of the metabolic activities of microorganisms, Kluyver reviewed the impressive variety of patterns encountered ["Eenheid en verscheidenheid in de stofwisseling der microben," *Chem. Weekbl.* **21**, 266 (1924)]. But his philosophically inclined mind was never content with mere collections of data; invariably he strove toward greater comprehension through the formulation of general principles. This has led to the enunciation of the great concepts of the "unity in biochemistry" and "comparative biochemistry" ["Die Einheit in der Biochemie" (with H. J. L. Donker), *Chem. Zelle und Gewebe*, **13**, 134 (1926); *The Chemical Activities of Micro-organisms* (University of London Press, 1931); "De stofwisseling van de plantaardige cel," in *Leerboek der algemeene Plantkunde*, V. J. Konigsberger, Ed. (Scheltema & Holkema, Amsterdam, 1942); pt. II, pp. 198–347; *The Microbe's Contribution to Biology* (with C. B. van Niel) (Harvard University Press, Cambridge, Mass, 1956)].

These concepts provided the impetus for a long series of extensive studies that were carried out in his institute on a large variety of microbes. The wealth of material collected in the monographs forms the solid foundation for future advance. Since many of the monographs were written in Dutch, it has become almost mandatory for microbiologists to familiarize themselves with this language.

The aforementioned principles have been immensely fruitful, as is shown by the tremendous advances in biochemical understanding since, and owing to, their inception. In addition, Kluyver keenly realized that microorganisms represent ideal experimental material for the study of metabolic processes and repeatedly instigated their use for this purpose. This notion has gained much ground; during the past 10 years, the number of biochemical investigations in which microbes have played a leading role have come to exceed by far those utilizing higher organisms.

The synthesizing ability of Kluyver's mind, coupled with his vast factual knowledge, have further yielded important contributions to the problems of classification, notably of yeasts and bacteria.

Kluyver's eminence as a biochemist and microbiologist has been widely acclaimed. He was elected to membership in many foreign scientific societies and was recipient of several honorary degrees and other signal distinctions. The award of the Copley medal by the Royal Society of London may be especially mentioned. Recognition in the United States is evidenced by sizable research grants from the Rockefeller Foundation; by the honorary degrees conferred upon him by Iowa State College and Rutgers University; by his election as foreign associate of the National Academy of Sciences, as a foreign honorary member of the American Academy of Arts and Sciences, and as an honorary member of the Society of American Bacteriologists.

Although Kluyver's inspiring influence will no longer be experienced directly, the impact of his vision and personality will continue to be felt. His publications are true classics of scientific reasoning; they will be read and studied for a long time to come. And the many scientists who have worked in his institute possess a priceless heritage that will make them realize the responsibilities imposed upon them by this very fact. Through them, his spirit will continue to live and to guide man along his path toward a richer and more humane life.

C. B. VAN NIEL
Hopkins Marine Station of Stanford University, Pacific Grove, California

The way in which the persecution of Galileo has been remembered is a tribute to the quiet commencement of the most intimate change in outlook which the human race had yet encountered. Since a babe was born in a manger, it may be doubted whether so great a thing has happened with so little stir.—A. N. WHITEHEAD.

News of Science

Congressional Recommendations to Promote Scientific Interchange

The executive committee of the Federation of American Scientists has issued a statement endorsing three proposals to promote scientific interchange that are included in a report released on 29 July by the House Government Information Subcommittee, which is headed by Rep. John E. Moss (D., Calif.). The FAS committee agreed with the subcommittee that

1) *The Export Control Act of 1949 should be amended to exempt unclassified scientific information from export regulations now administered by the Commerce Department.* Many U.S. scientists are "unwittingly violating the law" in their ignorance of a Commerce Department requirement that all unclassified scientific correspondence sent abroad be marked on the envelope with an export license "symbol," the FAS committee stated. When the labeling requirement is observed, however, it interferes with technical progress by discouraging the "flow of information" so vital to creative scientific thought.

2) *The State Department's science attaché program should be reactivated.* "The scientific community views with alarm the curtailment of the State Department's attaché program," which at its peak had 10 science attachés in U.S. embassies abroad. The FAS also urged "strengthening of the Science Adviser's Office in the State Department." This office has had only an acting head and skeleton staff since 1953, while the State Department has been reviewing the program begun in 1951.

3) *The Commerce Department's Office of Strategic Information should be abolished.* In this connection, the FAS committee stated: "Peacetime attempts to extend voluntary controls to any unclassified information are unrealistic and fraught with dangers far greater than the presumed benefits."

Mars Approaches Earth

On 7 Sept. Mars will come closer to the earth than it has been at any time since 1924. A few days later, on 10 Sept., Mars will be in opposition to the sun—that is, the earth, traveling in a smaller orbit than that of Mars, will catch up with Mars as the two revolve around the sun. Both planets will then be in line with the sun, with Mars on the night side of the earth and the sun on the daylight side.

Mars always makes its closest approach to the earth near times of opposition. Because of the periods in which the two planets revolve around the sun—earth, 1 year; Mars, slightly less than 2 years—oppositions occur at average intervals of about 2 years and 2 months. However, since the orbits of Mars and the earth are not circular, but elliptical, opposition distances between the two planets may vary from slightly less than 35 million miles to more than 62 million miles.

Mars is farthest from the earth when it is on the opposite side of the sun from us, called conjunction. The distance at such times may be as great as 235 million miles. The opposition next month will bring Mars to a distance of about 35,120,000 miles, about 5 million miles closer than its last previous opposition in 1954. The most favorable opposition in recent times took place in 1924, when Mars was 34,700,000 miles from the earth in the month of August. It will be several centuries before Mars comes that close again.

Because of the planet's close approach to earth in this year's opposition, Mars will be a conspicuous reddish object in the sky. As seen from New York, it will be in the southern sky from early evening until sunrise. One other feature that can be observed only at times of opposition is the retrograde or apparent backward motion of Mars. From 11 Aug. to 12 Oct. it will appear to move westward against the rather faint stars of Aquarius.

In order to insure an integrated program of 24-hour observation, the International Mars Committee was formed before the 1954 opposition, with E. C. Slipher and A. G. Wilson of the Lowell Observatory as cochairmen. Seventeen observatories in ten countries scheduled programs to investigate the dark markings and the temperatures of the Martian surface, the intricate network of "canals," the motions of the satellites Phobos and Deimos, the diameter of the planet, and many other problems in nearly all areas of planetary knowledge. Such observatories as Lamont-Hussey in Bloemfontein, South Africa; Pic du Midi in France; La Plata in Argentina (formerly Eva Peron); and McDonald, Lowell, Yerkes, and Mount Wilson and Palomar in the United States took part in the program.

Reports on the 1954 opposition by Slipher, who used the 27-inch refractor at the Lamont-Hussey Observatory, indicate the scope of the current observation project. At that one station, 20,000 photographs of Mars were taken over a period of 130 nights, only six of which were lost because of poor weather conditions. Atmospheric conditions on Mars itself were unusually favorable, and the equatorial cloud belt on Mars was photographed for the first time.

During the 1954 study period photographs revealed that a huge area, roughly twice the size of the island of Madagascar, had changed from its normal orange-red color to a dark green. Since the green areas are possibly regions of vegetation, this change may be significant of a change in the distribution of moisture and other factors which would encourage the growth of vegetation.

A strange cloud formation shaped somewhat like the letter *W* appeared above the surface of Mars every afternoon for about a month.

Intensive studies of Martian temperatures were made at the Palomar Observatory. The daily maximum temperature on Mars occurred from 15 to 30 minutes after local noon, and amounted to 77°F. However, the sunrise temperature in the same location was −58°F.

More important than any of these and other less spectacular discoveries was the experience in observation techniques gained at the 1954 opposition. This experience has permitted the best possible preparations for the 1956 approach, when Mars will show us 97 percent of its maximum possible apparent diameter.

Boshyan Down, Lysenko Up?

Soviet Minister of Agriculture Vladimir V. Matskevich has, according to a dispatch to the *New York Times*, denounced the work of the Soviet biologist, G. M. Boshyan, who was praised in the Soviet press in 1950 for experiments that were said to have revolutionized knowledge about viruses, bacteria, and immunization. Boshyan claimed in 1950 that bacteria and viruses were different forms of the same organisms and could be transmuted into one another, thus challenging the views held generally about the immutability of species since the time of Pasteur and Ehrlich. Matskevich said, in part:

"Experiments have been carried out without sufficient repetition, without the

use of certain necessary steps and without corresponding observations and research. The trustworthiness of the experimental data has not been checked by the method of mathematical analysis. . . . There have been cases where, as a result of lack of control and negligence on the part of heads of scientific institutions, untrustworthy data were published."

He further said that Boshyan had no real data to support his conclusions, and that what data he did have testified only to his ignorance of the problems.

Finally, Matskevich spoke approvingly of biologist Trofim D. Lysenko and commented that Lysenko's critics were trying to smuggle bourgeois ideas into Soviet science. Lysenko has been the center of an international controversy because he maintains that acquired characteristics can be inherited, an idea that is directly contradictory to prevailing genetic theory. His resignation as head of the All Union Academy of Agricultural Science was announced in Moscow last April [*Science* **123**, 722 (27 Apr. 1956); **119**, 909 (25 June 1954)].

Anthropometry and Industry

Anthropometric data may be, and are being, applied in a wide variety of situations. In a recent article, D. F. Roberts [*Am. Anthrop.* **58**, 526 (June 1956)] discusses the application of body measurements to various industrial problems and points out that there is a wide variety of situations in which they can be so used. Of direct interest to industry are problems of machinery design in which employment of anthropometric information can increase efficiency. The domestic applications of such data also concern the manufacturer, respecting the replacement of anatomically unsatisfactory furniture and appliances of conventional pattern by designs producing greater comfort and efficiency. The practical application of anthropometric data is not a simple problem, however; the biometrician, the anatomist, and the clinician are all involved.—W. L. S., JR.

European Atomic Agreement

On 11 July the French National Assembly approved French participation in the six-nation atomic energy community to be called Euratom. A treaty agreeable to the parliaments of the participating nations—France, Belgium, Italy, West Germany, the Netherlands, and Luxembourg—remains to be negotiated.

According to the proposal, Euratom would control the purchase and production of source materials for atomic energy, hold patents, and control the distribution of power, thus necessitating surrender of sovereignty in atomic matters by the six member nations.

Two days after the French approval the U.S.S.R. suggested the establishment of an all-European nuclear organization in which both the Soviet Union and the United States would take part. A circular distributed 13 July to the American, British, French, and other embassies proposed the organization as a substitute for Euratom. The Soviet statement charged Euratom would be a tool of the North Atlantic Treaty Organization. It asserted that West German participation in Euratom would deepen the division of Germany and, in effect, give the Germans the chance to manufacture atomic weapons.

Radio Telescope in West Virginia

A 140-foot radio telescope will be built in the Green Bank area of West Virginia, which is about 35 miles south of Elkins, with funds administered through the National Science Foundation. The site is advantageous because of the low level of radio interference in the frequency range of from 10 to 35,000 megacycles. This is owing to the absence of high-voltage power lines and the protection from man-made radiation provided by the mountains that ring the valley. Congress has appropriated $3.5 million for construction of the 140-foot telescope. Plans call for later construction of a 600-foot telescope in the same valley.

The decision about which organization will operate the radio observatory has not yet been announced by NSF, which is itself prohibited by law from engaging in direct operations or research.

Magnetite Crystals Grown by Hydrothermal Method

According to a report by the Office of Technical Services, U.S. Department of Commerce, magnetite crystals have been successfully grown at a rate of 0.05 millimeter per day by a hydrothermal process. Growth occurred in steel autoclaves containing ammonium chloride solution. Temperature at the top of the chamber, where the crystals grew, was 430°C and at the bottom 480°C. Pressure was about 22,500 pounds per square inch. Growth rate decreased with lower temperatures and pressures and practically stopped at about 400°C and 15,000 pounds per square inch.

Among various aqueous media used, only ammonium chloride promoted crystal growth through a hydrogen-producing reaction to steel alloys in the pressure vessels. The specific function of the solution is not yet clear. Evidence showed that the growth was the outcome of a chemical process and not of recrystallization of the parent material from a supersaturated solution. Although experimentation was primarily with magnetite, researchers believe that the process may be applied to production of other ferrites.

The OTS report, which is a summary of 2 years of research, was written by J. Koenig for the Air Force Cambridge Research Center.

News Briefs

■ The National Geographic Society has announced that the Swedish merchant ship Lommaren will sail from Goteborg, Sweden, early in September to gather data for a cosmic ray "map" of the world. The shipboard study is being sponsored by the society and the Bartol Research Foundation of Philadelphia's Franklin Institute, in collaboration with the National Research Council of Canada, the Physics Institute of Uppsala University, and the Transatlantic Company of Sweden. The seagoing laboratory will operate throughout the 1957–58 International Geophysical Year.

■ The synthesis of vasopressin, an antidiuretic and vasopressor hormone of the posterior lobe of the pituitary gland, has been accomplished by a group of workers at the Cornell University Medical College: M. F. Bartlett, A. Johl, R. Roeske, R. J. Stedman, F. H. C. Stewart, D. N. Ward, and V. du Vigneaud.

Scientists in the News

WILLIAM P. SENETT has been named head of the laboratory research department of Walter Kidde Nuclear Laboratories, Inc., Garden City, N.Y., and FREDERICK A. ZENZ has been appointed senior engineer. Previously, Senett was a research physicist with the Radio Corporation of America, studying germanium surfaces in solid-state physics, and Zenz was a development engineer with the M. W. Kellogg Company, supervising experimental work and analysis of catalyst flow phenomena, fluid bed heat transfer, and fluidized reactor design.

HAROLD J. MAGNUSON, formerly chief of operational research for the venereal disease program of the U.S. Public Health Service, has been appointed head of the service's occupational health program.

MARGUERITE M. ROGERS, head of the science division of Columbia College (Columbia, S.C.), will become lecturer in physics at the Royal Technical College, Salford, England, in September.

H. B. TUKEY, head of the department of horticulture at Michigan State University, has received the Norman J. Colman award of the American Association of Nurserymen.

BOWEN C. DEES and LOUIS LEVIN of the National Science Foundation have been appointed deputy assistant directors, Dees in the scientific personnel and education division and Levin in the biological and medical sciences division. Dees, a physicist, has been program director for fellowships since 1951, a position he will retain for the time being. Levin, who is a biochemist, also will retain his post as program director for regulatory biology.

KWANG SOO LEE, who formerly was associate professor of pharmacology at Jefferson Medical College, has been appointed associate professor of pharmacology at the State University of New York College of Medicine in Brooklyn.

JOHN A. SCHILLING has been appointed the first full-time head of the department of surgery at the University of Oklahoma School of Medicine. Also, LOUIS J. WEST has assumed his post as head of the department of psychiatry following his release from active duty with the U.S. Air Force.

JOSEPH H. ROE, professor of biochemistry and chairman of the department at the George Washington University Medical School (Washington, D.C.), has been selected by the American Association of Clinical Chemists to receive the 1956 Ernst Bischoff award for his work in clinical chemistry. He has contributed particularly to knowledge of carbohydrate metabolism, especially of fructose, of glycogenesis, and of vitamin C.

WALTER J. HAMBURGER, director and treasurer of Fabric Research Laboratories, Dedham, Mass., has received the 1956 Olney medal of the American Association of Textile Chemists and Colorists.

MERRILL M. FLOOD, formerly of Columbia University, has been appointed professor of industrial engineering and associate director of the Engineering Research Institute at the University of Michigan.

EDWARD ABRAMS, former head of the textile section at the Southern Research Institute, Birmingham, Ala., has joined the staff of the newly formed chemical preservative department of the National Gas Company, Chicago. He will direct the department's research activities.

JAMES K. HUNT, technical and educational adviser of the Du Pont Company's public relations department, has

retired after 30 years with the company. For many years he was a research chemist in the chemical department at the Experimental Station in Wilmington, Del., and in his more recent career he has been active in the local and national affairs of the American Chemical Society and the National Science Teachers Association. He has been particularly interested in the educational activities of industrial and professional organizations, including the science fairs that have now become annual events.

Hunt joined Du Pont in 1926, where he conducted research on a wide variety of subjects, including paints, varnishes, lacquers, drying oils, asphalt compositions, cellulose derivatives, coated fabrics, and textile finishes. Since 1937 he has been technical and educational adviser in the public relations department, in which capacity he has also worked closely with the authors of technical articles and with the editors and publishers of science textbooks.

Hunt was graduated from Alabama State Teachers' College in 1910 and from Alabama Polytechnic Institute in 1923. In 1926 the University of Wisconsin awarded him the Ph.D. degree.

LADISLAUS L. MARTON, chief of the electron physics section of the atomic and radiation physics division at the National Bureau of Standards, has been elected to the Royal Academy of Belgium in recognition of his contributions to science and particularly to the development of the electron microscope. Marton, who is the only American physicist among the foreign members of the academy, fills the vacancy left by the late J. Verschaffelt of the Netherlands.

The National Science Foundation has awarded travel grants to the following scholars to enable them to attend the eighth International Congress for the History of Science and the fourth general assembly of the International Union for the History of Science, to be held in Florence and Milan, Italy, 3–10 Sept.: GIORGIO D. DE SANTILLANA, Massachusetts Institute of Technology; CHARLES C. GILLISPIE, Princeton University; C. DORIS HELLMAN, Pratt Institute; THOMAS P. HUGHES, Washington and Lee University; GENEVIEVE MILLER, Western Reserve University; CHARLES D. O'MALLEY, Stanford University; DUANE H. D. ROLLER, University of Oklahoma; EDWARD ROSEN, City College of New York; RICHARD H. SHRYOCK, Johns Hopkins Medical School; WILLIAM D. STAHLMAN, Massachusetts Institute of Technology; G. KASTEN TALLMADGE, Marquette University; ILZA VEITH, University of Chicago; LESLIE P. WILLIAMS, Yale University; HARRY WOOLF, University of Washington.

RONALD C. VICKERY, British chemist who has worked for the past 5 years with the Commonwealth Scientific Industrial Research Department in Australia, has been appointed head of the chemistry department of Horizons Incorporated, research organization in Cleveland, Ohio. He is a specialist in rare earths.

HOWARD S. COLEMAN, who joined the Bausch and Lomb Optical Company in 1951, has been named vice president in charge of research and engineering.

Recent Deaths

GEORGE M. BALL, JR., Haverford, Pa.; 81; retired civil engineer; 24 July.

WALTER E. BUFFEY, Elizabeth, N.J.; 74; retired consulting chemist; 25 July.

CASPER V. CASPER, South Norwalk, Conn.; 59; chemical engineer; chief production engineer for the American Machine and Foundry Company; 29 July.

GUNNAR DAHLBERG, Uppsala, Sweden; 63; professor of genetics and director emeritus of the State Institute of Human Genetics at the University of Uppsala; 25 July.

ALBERT FISCHER, Copenhagen, Denmark; 65; cancer specialist who received the Louis Pasteur Commemorial Diplome de Grand Prix for his pioneering research; 31 July.

JOHN A. FLEMMING, Washington, D.C.; 79; internationally known geophysicist; retired director of the department of terrestrial magnetism for the Carnegie Institution of Washington; 29 July.

MARTIN B. GENTRY; Southern Pines, N.C.; 69; retired mining engineer; 31 July.

ALBERT V. HALLOWELL, Philadelphia, Pa.; 55; member of the Bureau of Medical Surgery of the U.S. Navy; associate professor of laryngology from 1924–40 at Hahnemann Medical College; 28 July.

ULRICH A. HAUBER, Davenport, Ia.; 71; professor and head of the department of biology at St. Ambrose College; 1 July.

RUSSELL D. HOLT, SR., Staunton, Va.; 86; member of the Indian Field

Medical Service for 35 years, including duty among the Navajos and Apaches in Arizona and the Pueblos in New Mexico; 26 July.

FRED R. JONES, Madison, Wis.; 71; former plant pathologist for the Bureau of Plant Industry, U.S. Department of Agriculture, and research associate at the University of Wisconsin; 5 Apr.

JOSEPH P. LAZANSKY, Homewood, Ala.; 57; associate dean of the University of Alamaba School of Dentistry; formerly associated with the University of Rochester School of Medicine and Dentistry and Tufts College; 27 July.

ROSCOE F. LEE, Washington, D.C.; 58; first Negro to receive national certification in the field of oral surgery; founder and former head of the oral surgery department at Freedmen's Hospital; 29 July.

MARTIN MEYER, New York, N.Y.; 57; retired professor and chairman of the department of chemistry at Brooklyn College; formerly associated with Antioch College and City College of New York; 28 July.

LEWIS F. MILLHAN, Scotia, N.Y.; 75; retired engineer for General Electric Company; 26 July.

HENRY B. MITCHELL, Riverdale, N.Y.; 82; former professor of mathematics at Columbia University; 30 July.

ROSCOE H. SUTTIE, New Haven, Conn.; 70; professor emeritus of civil engineering at Yale University; 30 July.

BENJAMIN H. UTAL, Philadelphia; 64; civil engineer; 30 July.

JOHN VON DANCZ, Newark, N.J.; 73; staff member of the Kennedy Research Laboratories; 25 July.

HARRY R. WAHL, Kansas City, Kans.; 70; professor of pathology at the University of Kansas Medical Center; former chairman of the department of Pathology and dean of the medical school at the University of Kansas; 18 June.

Education

■ A $38,000 grant from the Carnegie Corporation of New York to the American Society for Engineering Education will make possible a comprehensive study of technical institute education in the United States. G. Ross Henninger, assistant director of the engineering extension service at Iowa State College, will be director of the project, which will have a threefold purpose: (i) to identify the industrial, technological, and educational trends that influence the education and careers of graduates of 2-year technical institutes; (ii) to assess the place of the technical institute in higher education, and to determine the present capacity and status of technical institutes in the United States; and (iii) to project the future role of the technical institute in meeting this country's needs for scientific and engineering manpower.

The ASEE has also received a $40,000 National Science Foundation grant to support a study of the nation's needs for research in engineering. Eric A. Walker, vice president of Pennsylvania State University, will direct this second survey.

■ An agency for research on military problems, the Institute for Defense Analyses, has been established at Massachusetts Institute of Technology, one of five educational institutions participating in the institute. The new unit, which will be headed by Albert G. Hill, former director of M.I.T.'s Lincoln Laboratory, is a nonprofit corporation that will conduct scientific analyses of present and future weapons systems. Other initial members of the IDA are California Institute of Technology, Case Institute of Technology, Stanford University, and Tulane University.

■ The new University of Tennessee Memorial Research Center and Hospital was dedicated last month. The six-story building has 245,000 square feet of floor space. The general research area has 14 laboratories occupying 12,000 square feet, and there is another 8000 square feet of clinical laboratory space. Hospital capacity is 384 beds.

■ The R. T. French Company of Rochester, N.Y., manufacturers of bird foods and bird-care products, has established a professorship and a research fund in the Cornell University laboratory of ornithology. William C. Dilger, assistant professor of biology at St. Lawrence University, will be the first staff member appointed under the grant for the R. T. French professorship of ornithology. His appointment will be in the laboratory of ornithology as assistant director in charge of research projects, and he will also be an assistant professor in Cornell's conservation department.

The company is contributing $12,000 a year to support the chair and research on bird biology. The research will be especially concerned with studies of behavior, genetics, and nutrition of both caged and wild birds.

In the Laboratories

■ A British engineering firm, Mitchell Engineering, Ltd., London, has developed an automatic method of moving coal from the pit bottoms to hopper cars above ground. At the source, coal is automatically fed into tipplers, which tip the coal onto a moving belt. The belt conveys the coal to coal breakers, which reduce it to 3-inch lumps. These are then carried on the belt to bucket elevators, which carry them to the surface and automatically discharge them into hopper cars. The buckets are unusual in that they operate like grabs rather than by tilting. The system saves labor, inasmuch as only two men—one above and one below ground—are required for supervision of operations. It is expected that the device will permit a 90-percent reduction in the labor force, a saving urgently needed to enable Britain to meet her commitments of more than 1 million long tons of coal annually to the European Coal and Steel Community.

■ Argonne National Laboratory has announced the establishment of a Reactor Physics Constants Center. Plans for the center were made last January at a conference between the United States, the United Kingdom, and Canada, held in Chalk River, Canada. A tripartite group was proposed for the purpose of correlating and standardizing the data used in reactor physics. It was agreed that Argonne National Laboratory should form a group performing this function for the North American Continent, and that a similar group would be set up in the United Kingdom to act as a clearing house for the receipt and transmission of European data.

During the initial period of its operation, the center will be governed by a committee consisting of H. Greenspan, C. Kelber, W. Loewenstein, and B. I. Spinrad. The material covered will be unclassified and will be derived from unclassified sources. It is requested that individuals or laboratories who have data pertinent to the purposes of the center transmit such data, with complete references, to Reactor Physics Constants Center, Argonne National Laboratory, Lemont, Ill.; Attention: B. I. Spinrad, Reactor Engineering Division.

■ The Olin Mathieson Chemical Corporation has announced the formation of a nuclear fuel division to produce nuclear fuel elements and nuclear reactor cores. M. F. Meissner, corporate vice president, will be in charge of the new unit. Meissner also heads the metals division.

In order to begin output as quickly as possible, equipment is now being installed in space that has been reconstructed at the Winchester Arms plant in New Haven, Conn. Pilot operations are scheduled to begin there this month. A larger facility will be made operative within the next 18 months to permit full scale production of nuclear elements. No site has yet been selected for this plant.

Olin Mathieson is also erecting a $36-million plant at its Lake Ontario Ordnance Works in Model City, N.Y., about 14 miles north of Niagara Falls, where a new high-energy chemical fuel for use in missile and aircraft engines will be produced for the Air Force. The

company has been conducting research on the new fuel for the Department of Defense since 1952. In addition a smaller plant is being built to produce the same fuel for the Navy. The new facilities will be operated by the corporation's recently formed aviation division.

■ Arthur D. Little, Inc. has announced the opening of its Midwest Division—Miner Laboratories, through which all ADL research and consulting services are now directly available to midwestern industry. John R. Kirkpatrick is manager, and C. S. Miner, Jr., is technical director of the new division, which has laboratories at 9 S. Clinton St., Chicago, Ill.

■ A pressurized aircraft cockpit has recently been installed in an altitude chamber at the Wright Air Development Center. It will permit studies of pilot performance under conditions simulating altitudes as high as 150,000 feet. The cockpit can have its pressure raised to 5 pounds per square inch above that of the air in the surrounding chamber. By means of a diaphragm that can be punctured, air can be allowed to escape from the cockpit rapidly to simulate the loss of cabin pressure that might occur in flight and the consequent rapid decompression.

■ On 1 Aug. Sharp and Dohme, the pharmaceutical and biological division of Merck and Company, Inc., adopted the name "Merck Sharp and Dohme."

■ The General Electric Company has awarded to the New York Shipbuilding Corporation a $2 million contract for the engineering and construction of a large welded steel, atomic reactor tank for the Commonwealth Edison Company's 180,000-kilowatt Dresden nuclear power station, near Chicago, Ill. General Electric will build the all-nuclear plant for Commonwealth and the eight members of the Nuclear Power Group, Inc.

The cylindrical pressure vessel, of 12-foot 8-inch inside diameter and of approximate height of 42 feet, will stand upright inside a steel sphere. The sphere will be 190 feet in diameter.

The pressure vessel will have ⅜-inch stainless-steel cladding over the inside of a 5-inch thick carbon steel welded assembly. When filled, it will hold approximately 278,000 pounds of water. It will be designed for an operating pressure of 1000 pounds per square inch and an operating temperature of 544.6°F.

■ The Mellon Institute, Pittsburgh, Pa., will soon initiate a major research effort in the field of peaceful atomic energy applications. The institute has established a new department of radiation research to carry on the work and has purchased a 3-million-volt Van de Graaff particle accelerator as its initial radiation source.

The work that is being planned will embrace both basic studies on the nature of ionizing radiation and investigation of its practical applications in chemical processing. Robert H. Schuler, for several years a member of the staff at Brookhaven National Laboratory, has been selected to head the department, which he will join on 1 Sept.

■ A new device to obviate the necessity of driving test pilings in clay soil to determine sinkage under load has been developed by H. Bolton Seed of the University of California at Berkeley. The device is a rod with four projecting vanes. When the rod is pushed into the soil at various depths, enough torsional force is applied to make the vanes rotate. The force required can be correlated with results obtained with loaded piling and reasonably accurate predictions of sinking under load can be made from the "vane shear" tests alone.

Miscellaneous

■ The United Nations Educational, Scientific and Cultural Organization's New York office has announced a new group of science and engineering vacancies in the technical assistance programs. The openings, which are primarily for professors or senior lecturers in chemistry, physics, and power engineering, are in Egypt, Israel, Liberia, Pakistan, Paraguay, Thailand, Formosa, and India.

Salaries generally range from $6000 to $8750 a year, free of national income tax. Should the expert have a family, he receives a dependent's allowance of $200 a year for his wife, and a children's allowance of $200 a year for each child. Lodging is furnished by the host government, or a lodging allowance is paid in lieu thereof.

Travel expenses are paid to duty station and back. They are also paid for his wife and dependent children, if his contract is for a year or longer. Unless otherwise specified, initial contracts are for 1 year, with the possibility of renewal in many cases. For information, write to Mr. Arthur Gagliotti, UNESCO, United Nations, New York 17, N.Y.

■ The sixth volume of *Arctic Bibliography*, published recently by the Government Printing Office, lists and summarizes 5285 publications, chiefly from the years 1950 to 1954. This brings to 38,410 the number of references assembled in the series to date. The set of volumes, which have been sponsored jointly by the Army, Navy, and the Air Force, analyze the contents of books and articles on the arctic and subarctic. The research and compilation of the series has been performed by the Arctic Institute of North America.

Subjects emphasized in the current volume, and represented by 800 or more items each, are geology and mineral resources, geography, zoology, and medicine and physiology. The language coverage is essentially the same as in earlier volumes: 3255 of the publications listed are in English and 1215 are in Russian, with others in German, French, the Scandinavian languages, Italian, Japanese, and ten others. The nature and significance of the foreign-language publications are made clear by translated titles and summaries of contents.

■ The International Commission on Zoological Nomenclature has given notice that as from 20 Jan. 1957 it will start voting on the following cases involving the possible use of its plenary powers for the purposes specified against each case. Full details were published in the *Bulletin of Zoological Nomenclature*, vol. 12, pts. 4 and 5 (20 July 1956): (i) *depurator* Linnaeus, 1758 (*Cancer*), interpretation of, by neotype designated for (cl. Crustacea, order Decapoda); (ii) *Cherax* (emend. of *Cheraps*) Erichson, 1846, and *Palinurus* (emend. of *Pallinurus*) Weber, 1795, validation (cl. Crustacea, order Decapoda); (iii) *ferox* Gmelin, 1771 (*Accipiter*), suppression (cl. Aves); (iv) *Maja* Lamarck, 1801, validation of and designation of type species for (cl. Crustacea, order Decapoda); (v) *Sao* Barrande, 1846, and *Ellipsocephalus* (emend. of *Elleipsocephalus*) Zenker, 1833, validation (cl. Crustacea, order Stomatopoda); (vi) *Heteralocha* Cabanis [1851], validation (cl. Aves); (vii) *Acrodytes* Fitzinger, 1843, *venulosa* Laurenti, 1768 (*Rana*) and *tibiatrix* Laurenti, 1768 (*Hyla*), suppression (cl. Amphibia, order Salientia); (viii) *Palaeophonus* (emend. of *Palaeophoneus*) Lindström & Thorell, 1884, validation (cl. Arachnida); (ix) *Actinocrinus gilbertsoni* Phillips, 1836, interpretation of, by neotype (cl. Crinoidea). Comments should be sent as soon as possible to Francis Hemming, Secretary to the Commission, 28 Park Village East, Regent's Park, London, NW.1.

Erratum: Owing to a mistake in the release sent to us, the name of Willard H. Bennett appears as "Willard H. Beams" in the news item entitled "New Atom Smasher" on page 114 of the 20 July issue.

Erratum: In the obituary of Louis C. Karpinski on page 19 of the 6 July issue, the phrase "to the University of Strassbourg in France" is incorrect. Karpinski studied at the Kaiser Wilhelms-Universität zu Strassburg when Strassburg was in Germany.

Erratum: In the "Preliminary announcement of the seventh New York AAAS meeting," 25 May issue, page 949, the name "Society of Vertebrate Zoology" was mistakenly given as one of the cosponsors of the symposium on "Biotic communities in the past and today." The correct name of the society referred to is Society of Vertebrate Paleontology.

Reports

Spontaneous-Mutation Rates at Specific Loci in Drosophila Males and Females

In spite of the extensive work carried out since 1927 on the frequencies of radiation-induced mutation in *Drosophila melanogaster*, there is a dearth of information about the frequencies of spontaneous mutation at specific loci in this genetically best-known organism. Timoféeff-Ressovsky (*1*) reported a rate of about 3×10^{-6} for the occurrence of white eye color ($w^+ \rightarrow w$) but a far higher rate for the reverse mutation from bobbed-lethal to nonbobbed ($bb^{lz} \rightarrow bb^+$)—namely, 8.3×10^{-5}. The information was not given to indicate whether these mutations were the sum of occurrences in both the male and female parental germ lines or in only one.

Muller, Valencia, and Valencia (*2*) published preliminary data on mutation frequencies in the female germ line occurring at nine selected sex-linked loci. Sixty thousand individuals were examined. A very high rate of mutation, apparently characteristic of the strain used in the study, was obtained (3×10^{-5} per locus as the average for the nine loci).

Muller *et al.* divided this rate by 4, in order to bring it to a rate comparable to that of other strains, and concluded that "the frequency of gene mutations at the nine loci would *ordinarily* average between 10^{-5} and 7×10^{-6} per locus in females." (They also referred to a failure to detect any mutations of sex-linked eye colors in some 50,000 individuals examined by L. and E. Altenburg, which would indicate a rate significantly below 3×10^{-5} but not below 10^{-5} per locus.)

Besides the nine loci, the cut locus yielded nine mutations in 60,000 individuals, or a rate of 1.5×10^{-4}. In addition, there were 18 to 21 mosaic mutations involving one of the nine selected loci, four involving miniature, and four involving cut. None of these was transmissible. No gross rearrangements were found, but three mutants, all lethal white eye-color mutants, were considered to be presumptive deficiencies; of two that were examined cytologically, one was definitely found to be such.

These data, valuable as they are, suffer from the atypical character of the strain used, and even more from the fact that, insofar as useful comparisons are concerned, the spontaneous-mutation frequency was examined in the female germ line, whereas the induced-mutation studies have been almost wholly limited to studies of the male germ line. There is now ample evidence (*3*) to show that induced-mutation frequencies in the two sexes are not alike in many respects. It is therefore necessary to have a comparison of spontaneous-mutation rates at specific loci in both male and female germ lines.

In the course of an extensive study undertaken to determine the frequency of spontaneous dominant minute-bristle mutations in both sexes of *Drosophila melanogaster*, it was possible to detect mutation at certain marker loci as a by-product of the study (*4*). In each of the two crosses made, one for the determination of the mutation frequencies in the female germ line and the other in the male germ line, four marked loci were observed; but unfortunately, because of the high infertility found when yellow males are crossed with nonyellow females, the tester stocks used in the two crosses had to be different, and only one of the four loci was therefore checked in both crosses. The crosses were as follows:

Oregon-R ♀ X *pr cn; by; ci* ey^R ♂ (1)
Oregon-R ♂ X *y; bw; e; ci* ey^R ♀ (2)

Thus the mutants in the tester stocks to which the Oregon-R wild-type flies were crossed included, in the test of the female germ line, the genetic markers purple (*pr*) and cinnabar (*cn*) eye colors, blistery wings (*by*), and eyeless (ey^R); and in the test of the male germ line, yellow body color (*y*), brown eye color (*bw*), ebony body color (*e*), and eyeless (ey^R). No examination of individuals for the phenotype of the *ci* marker was undertaken. The results are set forth in Table 1.

The average mutation rate observed in the female germ line for the four marked loci was 2.5×10^{-6}. In the male germ line, excluding mosaic individuals, it was 5.75×10^{-5}—that is, 20-fold greater. Excluding all sterile mutant individuals, which could not be retested for transmissibility or for the genetic identity of the mutant, the rate in the male germ line is still 3.25×10^{-5}. Much of this high rate is evidently due to the high mutability of the *y* locus. If this locus is excluded in the comparison of the frequencies of spontaneous mutation in the male and female germ lines, the rate in the male germ line still amounts to 2.3×10^{-5}, a full order of magnitude greater than the rate in the female germ line.

Most significant is the comparison of the rates for the ey^R marker, which was the only locus checked in both tests. In the female germ line no mutations were found at this locus in 100,414 flies, indicating a rate less than 10^{-5}. In the male germ line there were six in 102,759, a rate of 6×10^{-5}, or, if sterile mutants are included, 3×10^{-5}. It should be emphasized that none of the *ey* mutants found had minute bristles or interrupted cubitus wing veins (*ci*), as would be the case if nondisjunction of the fourth chromosomes had occurred and the supposed mutants had actually been haplo-4

Table 1. Spontaneous mutations at specific loci in *Drosophila*.

Mutations in female germ line (Ore-R)			*Mutations in male germ line (Ore-R)*		
pr 1/100,414 (fertile ♂)	10^{-5}	*y*	6/51,380	(3 fertile ♀) (3 sterile ♀)	12×10^{-5}
cn 0/100,414	$< 10^{-5}$	*bw*	3/102,759	(2 fertile, ♂, ♀) (1 sterile ♂)	3×10^{-5}
by 0/100,414	$< 10^{-5}$	*e*	2/102,759	(2 fertile ♀)	2×10^{-5}
ey 0/100,414	$< 10^{-5}$	*ey*	6/102,759	(3 fertile, 1♂, 2♀) (3 sterile ♀)	6×10^{-5}
Sex-linked mutations			*Mosaics*		
f 1/50,207 (fertile ♂)	2×10^{-5}	*y*	3/51,380	(1 sterile ♀; 2 gynandromorphs)	
m or *dy* 1/100,414 (sterile ♂)	10^{-5}	*bw*	1/102,759	(sterile ♀)	
y, pn, w, rb, cm, ct, sn, lz, ras, v, s, g, r, car 0/702,898	$< 10^{-5}$				
Autosomal dominant					
S (?) 1/100,414	10^{-5}				

individuals. The relative abundance of mosaic mutant flies in the male germ line and their absence in the female germ line is also striking.

In cross 1 all sex-linked loci were also exposed to detection, but it is not clear how many might have been observed. Attention was directed only to relatively obvious changes in eye color and shape, body color, wing size and shape, and bristle size and shape. It seems clear that any mutations such as yellow or sable body color, forked or singed bristles, lozenge eyes, miniature, dusky, cut, or rudimentary wings, or prune, white, ruby, carmine, raspberry, vermilion, garnet, or carnation eye colors would have been noticed. Two mutations were observed: one to forked bristles, and another (sterile) to either miniature or dusky wings. The number of individuals examined per locus was about 50,000 (half of the total of 100,414). The mutation rate for sex-linked recessives in the female germ line may, therefore, be estimated as about 2.35×10^{-6}, which is in excellent agreement with the average frequency for the four autosomal loci specifically tested.

Although the data on spontaneous mutability should certainly be extended to include additional loci, the conclusion seems warranted from the present data that in *Drosophila melanogaster* the spontaneous-mutation rate at loci where visible mutants arise is about one order of magnitude larger in males than in females. So large a sex difference in mutability in *Drosophila* makes it imperative to investigate the question of whether a similar difference exists in other species, including the human.

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5 July 1956

Goldfish Erythrocyte Antigens and Serology

Incidental to an investigation of tissue-transplantation immunity in goldfish (*Carassius auratus*) (*1*), a preliminary study was aimed at detecting individual differences in the erythrocyte antigens of goldfish. Blood samples were taken and isoimmunization was accomplished by cardiac puncture, a 22-gage needle on a 1.5-ml syringe being most suitable. About 0.5 ml of blood may be safely taken from a 4-inch specimen, while up to 1.5 ml may be withdrawn from a 12-in-fish. Goldfish red cells keep about equally well in 0.7- to 1.0-percent saline but remain intact much longer in concentrated suspensions, especially in homologous plasma. For washing cells and making dilutions, 0.85-percent phosphate-buffered sodium chloride was used. The technique of tagging specimens and the effect of temperature on antibody production in fish have been discussed in full elsewhere (*1*).

Recent investigations of normal hemagglutinins in fish serums and of species differences in red-cell antigens of various fishes have been summarized by Cushing and Sprague (*2*). In the study reported here, normal serums from several different goldfish were checked for natural agglutinins at 1/4 and 1/8 saline dilutions against 2-percent suspensions of washed red cells from 12 other goldfish in standard agglutination tests (*3*). The tests were checked after 30 minutes and after 2 hours at room temperature, with and without centrifugation. No agglutination whatever was found. Normal serums from a variety of other animals were similarly tested for natural antibodies against goldfish red cells. No individual differences were detectable, because the red cells of all fish were agglutinated by a given serum to within one doubling dilution when heteroagglutinins were present. No absorptions of these normal serums were performed.

Proof of the existence of individual differences in goldfish erythrocyte antigens was first achieved by isoimmunization at room temperature. A large specimen was given a course of nine injections, each injection consisting of 0.3 ml of a 20-percent suspension of washed red cells from a particular fish of about the same age (4 years). Three injections were given per week. The agglutination titer checked by trial breedings was only 1/8 6 days after the third injection, but rose to 1/1024 7 days after the ninth injection. The serum was stored frozen and subsequently was used with no further processing.

An absorption analysis of this isoimmune serum was made using red cells from 11 unrelated goldfish. About 1 ml of blood was taken from each fish, and the cells were washed twice in saline. A small aliquot of each sample was then removed to prepare a 2-percent suspension for testing, and the remainder was divided equally in two tubes for absorptions. The isoimmune serum was diluted 1/8 in saline, and 0.5 ml of the diluted serum was thoroughly mixed with the packed cells of each fish for two successive absorptions of 30 minutes each at room temperature. The absorbed serums were then diluted 1/3 in saline for standard agglutination tests. Two fish, including the control recipient, possessed no antigen that reacted with this serum. The erythrocytes of the other nine fish gave positive reactions which revealed the presence of at least five antibody subpopulations recognizing individual antigenic specificities.

Two additional isoimmune serums were prepared as before by nine injections of two unrelated goldfish, respectively, with red cells of two parents from which offspring were being reared. The unabsorbed serums agglutinated the homologous cells to a titer of 1/1024. By the time the F_1 progeny were large enough (2 years old) to provide sufficient blood for an absorption analysis the P_1 ♂ had died. Nevertheless, 2-percent suspensions of the washed red cells of 11 F_1 siblings were tested against doubling dilutions of both unabsorbed isoimmune serums. All of the F_1 cells were agglutinated within two doubling dilutions of each other by both serums; hence, no differences were demonstrable among the F_1 siblings by this method. However, it is apparent that one or more antigenic specificities shared by the parents and their progeny are absent in the individuals that developed these isoimmune antibodies. These specificities represent inherited individual differences in the antigens of goldfish red cells.

Several rabbit antigoldfish red-cell serums were prepared by giving a series of injections of washed red cells in the marginal ear veins. Cross-absorption analyses were made with one such antiserum, using red cells from ten goldfish in addition to the donor. Washed cells prepared from 1-ml blood samples taken from each fish were divided among four tubes for absorptions. To each of the first absorption tubes 0.5 ml of antiserum at 1/8 dilution was added. Each of the first three absorptions was carried out at 10°C for 15 minutes in order to minimize hemolysis. The final absorption was at room temperature for 30 minutes. After the last absorption, each serum reagent was further diluted 1/4 in saline for lytic tests.

Each test consisted of 0.2 ml of serum reagent and 0.1 ml of 2-percent red-blood-cell suspension; after shaking, 0.1 ml of guinea-pig complement at 1/4 dilution was added. Appropriate serum, complement, and saline controls were also run. In all four of the absorption analyses, the red cells of the fish that were tested completely removed antibodies for each other but left in hemolysins for the cells of the donor used in immunization. Thus, only one antigen could be distinguished among the fish tested. The reciprocal removal of antibodies for red cells other than those of the donor was not a consequence of overabsorption, be-

cause, whenever fewer cells (or tubes) were used, the absorptions proved incomplete for the absorbing cells.

The extent of absorption also proved to be critical when agglutinating, rather than lytic, tests were performed with this same rabbit antiserum. After three absorptions performed at room temperature, only one antigenic factor could be distinguished. When sufficient blood was obtained from each fish for four absorptions, the antibodies directed against the individual antigen(s) previously detected were completely removed. The ease with which antibodies specific for individual differences were completely absorbed indicates that closely related antigens were involved in these antibody reactions. This finding is analogous to the well-known A_1 and A_2 specificities of human erythrocytes. Despite the difficulty of working with smaller species, it is probable that future investigations will show that inherited individual differences in erythrocyte antigens are widespread among fishes and other lower vertebrates.

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* U.S. Public Health Service research fellow of the National Cancer Institute.

13 July 1956

Visual Contour and Movement Perception

The means by which the visual system forms and maintains a contour is a central problem in vision, and one not well understood. By contour we mean the sharp boundary that separates two adjacent areas of the visual field. Specific studies of contour perception are few in number. Investigations of static and dynamic visual acuity, form perception, and visual-contrast phenomena all bear directly upon the subject of contour, but they all assume the operation of a contour-formation process without inquiring into the fundamental nature of the process itself. These allied phenomena in vision will be understood only when the essential facts of contour formation are known.

This report presents some preliminary observations on the subject of contour perception in relation to moving stimuli, a problem that has received little attention from those who have studied visual processes. The observations presented here stem from a phenomenon originally observed by Albert Michotte of the psychological laboratory at Louvain University in Belgium.

A stimulus (A) is observed moving horizontally through distance (D), from left to right. Its velocity (V) is increased until the contours of A cannot be seen clearly. At this velocity, if A is exposed for a brief interval in a fixed position prior to movement (this interval we shall call t_1) and then for another interval in a fixed position after movement (we shall call this interval t_2), A now is seen moving from left to right with sharp contours. This effect has been systematically explored by investigation of the quantitative relationship between the exposure durations of the stimulus in the fixed positions and the velocity of movement.

With an apparatus similar to the one employed by Michotte (*2*), a large white disk whose surface is perpendicular to the line of sight is rotated behind an aperture 6 in. long and 0.5 in. high. A concentric band on the disk is observed as a stationary square when the disk rotates. A band falling toward the center of the disk is translated into horizontal movement. By varying the speed of rotation of the disk and the length of the concentric bands, the necessary control over velocity of movement and exposure duration of the stimulus in the fixed positions is achieved. Figure 1 depicts the appearance of the black stimulus before, during, and after movement. The angular size of the stimulus object was 0.5°. The field of movement (D) was 5°.

For five subjects, the value of V at which contour was lost was determined with t_1 and $t_2 = 0$. At this velocity, t_1 and t_2 were increased by equal amounts in steps of 10 to 20 msec to some value (T) at which contour was regained. This procedure was continued until either the subject's limit of discrimination or the limitation of the apparatus was reached. The latter limitation concerned the exposure duration of t_1 and t_2. These values could not exceed 350 msec.

When the values of V are plotted against the values of T for each subject and these individual functions are combined, we get the relationship between V and T shown in Fig. 2. Because of the procedure employed, points were not always in common at different values of T for all subjects. Consequently, appropriate values of V were interpolated from the individual functions at 50-msec intervals of T. These values were averaged to give the points plotted in Fig. 2. Each point represents a mean of five values. This figure also includes data for vertical movement

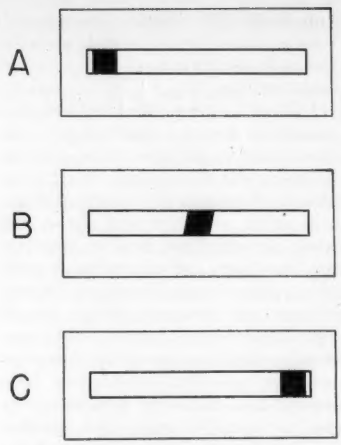

Fig. 1. Schematic illustration of the appearance of the stimulus as seen by the subject before movement (A), during movement (B), and after movement (C).

were gathered after the observations of horizontal movement.

The linear functions in Fig. 2 may be thought of as *contour-contours*. All combinations of velocities and time values falling to the right of these lines will not produce contour, whereas all combinations to the left will. Figure 2 shows clearly that the contour of moving stimuli can be maintained as velocity increases, as long as the stimulus is exposed for a longer and longer time, both before and after movement. At some velocity this relationship breaks down, and the function becomes asymptotic to the ordinate. We cannot specify this critical velocity now because of apparatus limitations. The

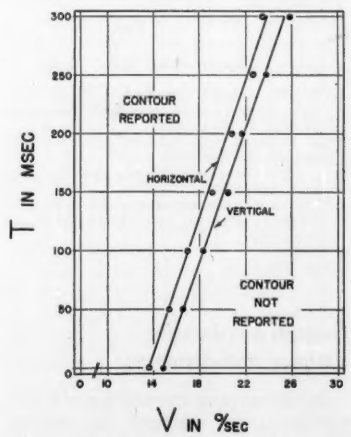

Fig. 2. A plot for horizontal and vertical movement showing the relationship between the velocity of the stimulus (V) and T, where T is the exposure duration of the stimulus before (t_1) and after (t_2) movement. In all instances $t_1 = t_2$.

results emphasize the critical importance of the temporal factor in contour perception. In order to maintain the contour of the moving stimulus, each increase in V of 1°/sec requires a corresponding increase in T of from 20 to 30 msec.

The criterion of judgment required of the subjects eliminates apparent movement as the explanation of the data reported here. The stimulus during movement was always tilted slightly to the right, (see Fig. 1), because of the nature of the apparatus. As long as this feature of the stimulus was reported, it was taken to indicate that real movement was being discriminated. It is believed, however, that the visual mechanism underlying apparent movement is involved to some extent in these observations, as it probably is in *all* forms of movement perception.

Further experiments dealing with the effects of numerous stimulus variables in relation to contour perception of moving stimuli are in progress.

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* Aided by a grant from the National Science Foundation.

19 June 1956

Notes on the Ecology of West Indian Species of Malpighia

Interest in the West Indian or Barbados cherry (*Malpighia glabra* or *M. punicifolia*) becomes greater every year as the commercial use of this fruit increases. The discovery in 1946 of its unusually high vitamin-C content has led to the addition of its juice to other baby-food juices to fortify their vitamin content. Recent reports have shown that the fruit supplies thiamine, riboflavin, niacin, and vitamin A, besides calcium, iron, and some phosphorus. As a result, propagation and cultivation of the plant has reached unprecedented proportions in Puerto Rico. However, the incidence of nematodes in the soils of the northern coasts of Puerto Rico where cherry culture is well established has produced serious problems. Studies have been made of other species of the genus to determine their resistance to root knot and their compatibility as stock material on which to graft susceptible species.

Ledin stated that the West Indian cherry has been in Florida for more than 50 years, where it is called *M. glabra* (*1*). He further believes that it is the same plant that is called *M. punicifolia* in Puerto Rico or that the two may be different forms of the same species. Woodbury accepted two different cultivated species but is now willing to concede that there is confusion in the taxonomy of the group (*2*). The possibility that the cultivated material is of hybrid origin has also been suggested. Asenjo (*2*) finds no appreciable differences in the vitamin content of the taxa studied.

The taxonomy of the Caribbean species is highly confused. Studies now in progress by W. T. Stearn of the British Museum (Natural History) and N. Y. Sandwith of Kew, England, include the investigation of type and other classical specimens, most of which are in European herbaria. Pending the outcome of these basic studies, opinions of local botanists on the correct identity and names of these taxa seem to be purely conjectural.

Some species are more resistant to nematodes than others. Studies of graft compatibility between these species and cultivated material are in progress. Differences in stem size among plants of comparable age indicate that some species are unsuited as rootstock material. In this group are *M. linearis* and *M. coccigera*. In other instances, the abundance of deciduous stinging hairs reduces the desirability of otherwise potential understock species. This is especially true of *M. infestissima*, *M. shaferi*, and *M. fucata*.

Malpighia is a genus of some 30 species of shrubs and small trees of tropical and subtropical America, all of which are found in the native state in the West Indies. Cuba has some 20 wild species, six of which are endemic (*3*); Hispaniola has 15, which have been reported by Moscoso (*4*), but only five are endemic; Jamaica has eight with one endemic, as inferred from Fawcett and Rendle (*5*); and, in Puerto Rico, there are only six, two of which, and possibly a new one, are endemic. The distribution of these wild species is rather limited to the Greater Antilles. *Malpighia coccigera* extends as far south as Martinique and St. Lucia; *M. urens* reaches St. Vincent and Bequia of the Grenadines; and *M. linearis* reaches to Guadeloupe. Greater concentration seems to be northward and westward, especially on the larger bodies of land.

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23 May 1956

Statistical Estimation of the Size of a Small Population

The technique of estimation discussed in this report is restricted to the following methodological approach. A sample of one is drawn at random, tallied, marked for future identification, and replaced. As trials progress, individuals that had been marked are drawn with increasing frequency. These, of course, are replaced without being tallied, and eventually the process is terminated on the assumption that the population has been exhausted. Estimate of the size of the population thus depends on the criterion selected by the observer.

The criterion proposed here provides not only an estimate but also a statement of confidence regarding the estimate. The rational basis for this criterion and the computation procedure that it demands are illustrated in the following two examples. In the interest of clarity, the result of each drawing is shown graphically with a check in the appropriate square on cross-section paper. Consecutive drawings are numbered on the abscissa, and occurrences of unmarked individuals on the ordinate. Since the first drawing invariably yields an unmarked individual, the first result is always recorded as a check in the square adjoining the origin.

Figure 1*A* illustrates a hypothetical case in which every drawing yields the same individual. At the end of r_1 drawings the observer may terminate the sequence with a statement that the population consists of a single member. In making this decision, the observer rejects the alternative hypothesis of a population consisting of two members with only one of these appearing in every sample. The probability of this alternative, $p = (\frac{1}{2})^{r_1-1}$, may be equated to any desired decimal, and the value of r_1 may be computed. This value represents the minimal number of times that the same individual must be drawn if the probability of type-II error is to be no greater than the selected decimal (*1*).

In the present illustration the probability of rejecting the alternative hypothesis when true has been set at 10 percent. The equality, $(\frac{1}{2})^{r_1-1} = 0.10$, yields 4.3 as the value of r_1. Since the nearest larger integral value is 5, the conclusion is that there must be at least five consecutive drawings of the same individual be-

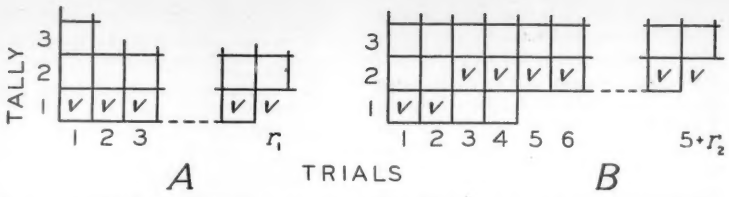

Fig. 1. Graphic representation of the results of sampling: (*A*) only one individual observed during sampling; (*B*) two individuals observed, the second occurring for the first time on the third trial.

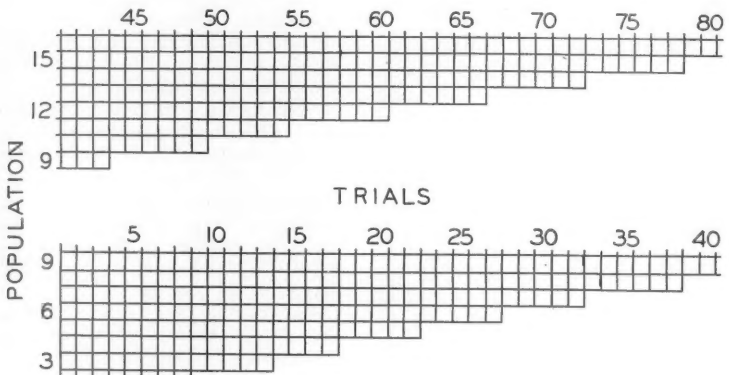

Fig. 2. Region that does not warrant acceptance of hypotheses regarding size of the population at 90-percent level of confidence. Any entry beyond the right boundary warrants such acceptance, with the estimate given by the ordinate at which the entry is made.

fore one may state with a 90-percent or higher degree of confidence that the population consists of a single member.

Figure 1*B* illustrates another hypothetical case in which unmarked individuals are observed on two of the first five drawings. In the diagram, observation of the second unmarked individual is located at the third trial, although, of course, the event may occur on any one of the four trials following the first. Should every individual drawn subsequently be found to have been marked, the observer is again confronted with the problem of ascertaining the minimal number of additional drawings that would permit him to state with 90-percent confidence that the population consists of only two members.

Assuming, for the moment, that the process is terminated after r_2 additional drawings, one considers the probability of type-II error in the rejection of an alternative hypothesis that the population is of size three. The error may be committed in either of the following ways: (i) by accepting, after five drawings, the hypothesis that the population is of size one, or (ii) by accepting after drawings of $5+r_2$ the hypothesis that the population is of size two. Calculation of the sum of probabilities of the two events may be facilitated by the Markov process, after the manner suggested by Feller (*2*):

$$ {}^{N}p_{ab}{}^{(r)} = \binom{N-a}{N-b} \sum_{v=0}^{b-a} (-1)^{b-a-v} \binom{b-a}{v} \left(\frac{a+v}{N}\right)^{r} \quad (1) $$

The symbol on the left reads as the probability of a change in state from a to b in r trials, given N states. In application to the present problem, it is the probability that a population of size N, a of whom have been tallied and marked, will have a total of b different members tallied and marked after r additional drawings. Interpreted graphically, it is the probability of transition from (x, a) to $(x+r, b)$.

The sum of the two probabilities is now written in this notation and equated to 0.10, thus,

$$ {}^{3}p_{01}{}^{(5)} + {}^{3}p_{02}{}^{(5)} \cdot {}^{3}p_{22}{}^{(r_2)} = 0.10 \quad (2) $$

The only unknown here is r_2, and solution of the equation yields $r_2 = 3.5$. This implies that the observer must have at least four consecutive drawings of marked individuals beyond the fifth observation if he is to state with 90-percent confidence that the population is of size two.

By following the procedure illustrated in these two examples one may establish terminal points for higher values on the vertical axis. The calculations become somewhat complex, but the basic approach remains the same. Figure 2 shows the terminal boundary that I computed for 90-percent confidence which is adequate for a population not exceeding 15 members. Current work includes extension of the boundary for higher values of the population and construction of boundaries for other levels of confidence.

Problems in research to which the criterion is applicable arise frequently, one of the most pertinent being the enumeration of wild-life specimens in a circumscribed area. Another example is one in which size of the population has no importance of itself, except insofar as the experimenter wishes to test every available member in order to increase the statistical significance of his results. The method is also being examined for potentialities of application to research in psychology. One promising possibility is that of a criterion of mastery in conditioning, based on my premise that a conditioned response depends on recurrence of one of a finite number of specific vigilance reactions (*3*).

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13 June 1956

Enzymatic Reduction of Disulfide Bonds in Cell Wall Protein of Baker's Yeast

The presence of a pseudokeratin-type protein, which contains 2.1 percent sulfur, has been demonstrated in isolated, clean cell walls of baker's yeast (*1*). The protein was solubilized and found to be firmly attached to a mannan component of the cell wall. Physical studies on this mannan-protein, which constitutes a major structural component of the yeast cell wall, indicate that it is monodisperse. It can now be reported that enzymatic reduction of disulfide linkages in the protein has been achieved by the use of cell-free particulate preparations from baker's yeast (*2*).

Portions of pound cakes of baker's yeast (Anheuser Busch, *3*), suspended in 8.5-percent (weight per volume) sucrose solution containing 5 percent (volume

Table 1. Enzymatic reduction of disulfide linkages in cell-wall protein of baker's yeast.

Reaction system*	Mercaptide formation† (Optical density at 255 mμ)	
Cell-wall protein, oxidized	0.137	0.656
Mitochondrial particulates	0.519	
Cell-wall protein + particulates	0.780	
Cell-wall protein, oxidized	0.137	0.381
Heated mitochondrial particulates	0.244	
Cell-wall protein + heated particulates	0.379	

* The components indicated were added to the following basal mixture and incubated at 37°C for 2 hr: sodium succinate, 10 mg; ethanol, 4.5 mg; liver coenzyme concentrate (Armour) 0.5 mg; and 0.02*M* phosphate buffer, *p*H 7.0. The reaction volume was 3.8 ml. Where indicated, 625 μg of cell-wall protein and 0.5 ml of mitochondrial particulate suspension (in 8.5-percent sucrose) were added.

† For determination of the sulfhydryl content of protein, the mixtures were centrifuged at 22,000*g* for 20 min to remove particulate matter, and 2.0-ml samples of the clear supernatant were added to 1.0 ml of 0.3*M* acetate buffer of *p*H 4.6, and 0.5 ml of $1.17 \times 10^{-4}M$ *p*-chloromercuribenzoate (assayed spectrophotometrically at 234 mμ in 0.1*M* acetate buffer of *p*H 4.6, according to the method of Boyer, *5*). Mercaptide formation was allowed to proceed for 2 hr at 37°C and then was determined at 255 mμ.

per volume) of redistilled thiodiglycol (2,2′-thiodiethanol), were broken by agitation with glass beads in a Waring Blendor according to the technique of Lamanna and Mallette (*4*). The particulate fraction was separated from cell-wall fragments and other debris by low-speed centrifugation, followed by repeated washing in 8.5-percent sucrose solution (without thiodiglycol) and centrifugation at 14,000*g*. The particulate fraction obtained was determined microscopically to be free of intact cells and of cell-wall fragments. These mitochondrial particulates were incubated together with a coenzyme concentrate, with succinate and ethanol as hydrogen donors, and with the mannan-protein (oxidized) isolated from clean cell-wall fragments (*1*) as a hydrogen acceptor. Sulfhydryl groups of the mannan-protein were oxidized with 0.001*M* ferricyanide as in the method of Anson (*5*).

After incubation for 2 hours at 37°C, the particulate matter was removed by high-speed centrifugation. The sulfhydryl content of the soluble cell-wall protein in the supernatant fraction was measured by spectrophotometric determination of mercaptide formation with *p*-chloromercuribenzoate according to the method of Boyer (*6*).

As is shown in Table 1, the complete system, containing oxidized cell-wall protein (equivalent to about $10.8 \times 10^{-5}M$ sulfur), mitochondrial particulates, and $11.7 \times 10^{-5}M$ *p*-mercuribenzoate, showed mercaptide formation equivalent to $2 \times 10^{-5}M$ *p*-mercuribenzoate after a reaction time of 2 hours. The same system with heated particulates had no greater absorbancy than the sum of its components. This analysis constitutes definitive evidence for the formation of sulfhydryl groups in the cell-wall protein on incubation with an active enzyme preparation. Disulfide reductase systems have been described that operate on oxidized glutathione (*7*) and on cystine (*8*), but this is the first time that enzymatic reduction of disulfide linkages of a protein has been demonstrated.

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19 June 1956

Blockade of Cardiac Synapses by Succinylcholine

The pharmacology of succinylcholine has been intensively studied (*1, 2*), particularly since the cholinomimetic drug is widely used as a relaxant in surgery. Nevertheless, its action on cardiac synapses, which is the subject of the present report, has not been hitherto described. This action is the blockade of the cardiac effects normally produced in the cat by stimulating the preganglionic vagus or the postganglionic inferior cardiac nerve. These findings have theoretical importance (*3*) and may possibly have some clinical bearing as well. The present account is limited to the manifestation of total blockade of the effects caused in the heart by maximal stimulation of the nerves (*4, 5*).

Eight cats anesthetized with Nembutal (35 mg/kg) and five spinal preparations unanesthetized after transection of the cord at C_1 under ether were used for this series of experiments. Artificial ventilation was instituted as needed after the transection in the spinal preparations and as respiratory paralysis developed in the Nembutalized cats. Both vagi were cut to prevent cardiac reflexes, and their peripheral segments were placed on a pair of stimulating electrodes. The inferior cardiac nerve was cleared of connective tissue close to its origin in the left stellate ganglion and also placed on stimulating electrodes. The stimuli were square pulses, supramaximal in the present experiments and usually 0.5 msec in duration. They were repetitive at 20 or 30 per second, but in some experiments frequencies of stimulation as low as 10 per second were also used. The actions of the nerves on the heart were recorded as the electrocardiogram in one or several lead combinations on a standard multichannel inkwriter (Grass model III). The electrocardiographic effects of stimulating the inferior cardiac nerve varied in different preparations, the extremes being shown in Figs. 1*A* and 2*A*.

Intravenous injections of 2 to 3 mg/kg

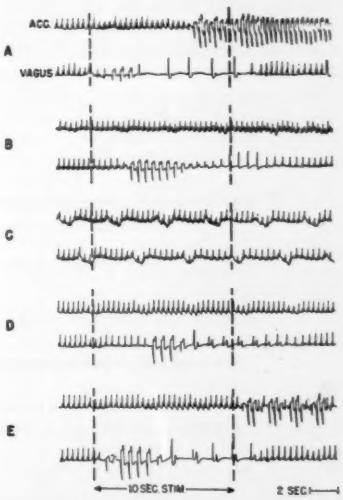

Fig. 1. Reversible cardiac synaptic blockade induced by succinylcholine in anesthetized cat. Upper trace of each set shows effects of stimulating inferior cardia nerve; lower shows results of stimulating the vagus nerve. (*A*) Prior to intravenous injection of succinylcholine; (*B*) 5 min after 8 mg/kg succinylcholine, sympathetic blockade was established, but not vagal; (*C*) 5 min after injecting 15 mg/kg additional, vagal blockade almost complete; (*D*) 30 min later, stimulation of vagus nerve again produced marked effects; (*E*) 1 hour later than *D*; blockade was almost completely reversed.

of succinylcholine caused marked changes in the neural effects on the heart, largest when the stimuli were submaximal, but also evident with maximal stimulation (Fig. 2*B*). However, total blockade of the effects of maximal neural stimuli required larger doses, ranging from 8 to 50 mg/kg (Figs. 1*C*, 2*C*). This total blockade was reversible (Fig. 1*D*, *E*). In all the Nembutalized preparations, sympathetic effects were eliminated before vagal blockade developed fully (Fig. 1*B*, *C*). In all five experiments with spinal, unanesthetized animals, on the other hand, vagal blockade developed somewhat earlier than did the sympathetic (Fig. 2*B*, *C*). There was also an increase in the basal cardiac rate with successive injections of the drug into the spinal animals (Fig. 2), whereas no marked changes of this occurred in the Nembutalized animals (Fig. 1).

Because of the different experimental conditions obtaining in the different tissues, the relative dosages of succinylcholine required for neuromuscular and cardiac blockade cannot be directly compared on the basis of the available data. In the cat, neuromuscular transmission is blocked for about 10 min by 0.25 mg/kg of the drug (*2*). On the other hand, 50 mg/kg is required to cause paralysis lasting 1 hr in the rabbit (*1*). As may be seen in Fig. 1*D*, *E*, 23 mg/kg of succinylcholine caused vagal blockade lasting ½ hr and sympathetic for 1½ hr. The cardiac actions of the drug described here therefore appear to be within the range of its pharmacological effects on other tissues.

Succinylcholine is a cholinomimetic agent that acts like acetylcholine or decamethonium (*6*) to depolarize muscle endplates prior to blocking neuromuscular transmission. Its blockade of vagal cardiac effects resembles the cardiac action of another "depolarizing" drug, nicotine, when the latter is applied slowly and in low concentration (*7*). In neither case is a slowing of the heart observed such as occurs with injections of acetylcholine or larger concentrations of nicotine. The vagal blockade caused by succinylcholine is therefore ascribable to depolarizing blockade of transmission from the preganglionic vagus to the intracardiac postganglionic parasympathetic fibers. Succinylcholine appears to lack the direct, "muscarinic" action of acetylcholine upon the cholinergic myocardial effector junctions, since large quantities of succinylcholine do not decrease, but rather increase, the rate.

Blockade of the cardiac effects of stimulating the postganglionic sympathetic inferior cardiac nerve can be instituted only at the appropriate myocardial effector junctions. Therefore, although the latter are predominantly adrenergic, the generally cholinomimetic agent succinylcholine also acts on these. Since the excitatory cardiac junctions probably develop depolarizing postjunctional (or postsynaptic) potentials, succinylcholine blockade of myocardial effects might come about through a depolarization of these junctions such as succinylcholine also produces at the cholinergic neuromuscular synapses (*8*).

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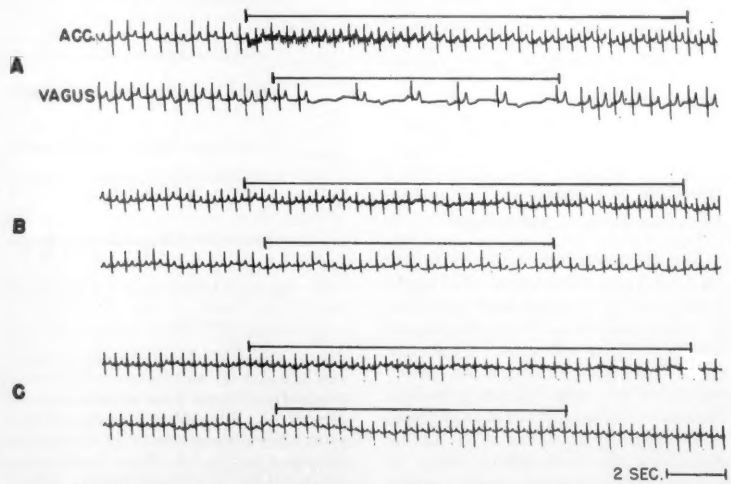

Fig. 2. Vagal blockade developing earlier than that of sympathetic stimulation in a spinal cat. Sequence as in Fig. 1. Bars indicate periods of stimulation. (*A*) Stimulating cardiac nerve produced a relatively small effect, an increase of 20 percent in rate; (*B*) 2 min after injection of 3 mg/kg succinylcholine; basal rate increased about 10 percent, but sympathetic stimulation again increased this by 20 percent; vagal stimulation became much less effective than before; (*C*) 2 min after complete blockade was instituted by an additional injection (15 mg/kg); basal cardiac rate, now 40 percent higher than originally, is not affected by stimulating either nerve.

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† Special research fellow, National Institute for Neurological Diseases and Blindness. Supported by Donner Foundation.
‡ Supported by grants from the Muscular Dystrophy Associations of America, National Science Foundation, United Cerberal Palsy Associations.

11 June 1956

Biological Decontamination of Fission Products

It is well known that phyto- and zooplankton are contaminated by radioactivity in fairly high concentrations. L. A. Krumholz (*1*) reported that *Volvox*, *Pandoria*, and *Euglena* acquired radioactivity that was 100 times greater than that of water containing fission products at White Oak Creek, Tenn. According to the report (*2*) of the research vessel *Shunkotsu Maru*, around Bikini Atoll in 1954, the extent of radioactivity detected in such zooplankton as copepods was 1000 times greater than that of the sea water that they inhabited. Although the mechanism of the accumulation of radioisotopes in plankton and the action of the radioisotopes in the organism are still vague, it is certain that plankton selectively accumulate specific radioactive elements from the water into their bodies. For example, Boss (*3*) announced that most phytoplankton had high selectivity of Y^{90} and *Carteria* of only $Sr^{89,90}$ from a culture medium containing $Sr^{89,90}$ and its daughter-product Y^{90}.

It has been reported (*4*) that *Aphanocapsa koordersii*, abundant in brackish lake water, are consumed by *Brachionus plicatlis* during the latter's breeding season, and the latter begin to perish with the decrease in the abundance of the former

as available food and to sink to the bottom of the lake. If such a limnological process as this were applied artificially to water containing wastes of fission products, some economies in waste disposal might be effected.

A beaker containing 1 lit of water taken from a brackish lake (Cl = 4.42 percent), with fission products (batch No. 19 from the U.S. Atomic Energy Commission) subsequently added to give a concentration of 0.2 μc/lit (2×10^{-4} $\mu c/cm^3$), was prepared as an original culture medium (*5*). In this medium, the population density of *Aphanocapsa* was found to be 4×10^6 cell/cm^3. Ten-cubic-centimeter samples of the culture were taken from the beaker after 3, 19, 44, 92, and 140 hours and were centrifuged every 15 minutes at 5000 rev/min to separate the precipitate (*Aphanocapsa*) from the upper water. Samples of *Aphanocapsa* and the upper water were dried in a stainless steel planchet, and their radioactivities were measured at a fixed distance below a Geiger-Müller tube (lead-shield thickness, 4 mg/cm^2). The results of this experiment are shown in Fig. 1. It was found that about 30 percent of the radioactive elements present in the culture water was absorbed by *Aphanocapsa* under these experimental conditions.

The ability of *Aphanocapsa* to assimilate radioactive elements from the culture water was thought to be so completely exhausted after about 140 hours that the *Brachionus* were added into a beaker at the rate of five pieces per cubic centimeter. The beaker was kept in a thermal-constant box at about 20°C. After the adding, 10-cm^3 of samples of the culture water were removed after 24, 43, 120, and 288 hours and separated under conditions previously described.

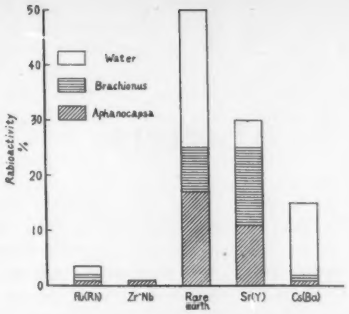

Fig. 2. Uptake of various radioactive elements from water containing fission products by *Brachionus* and *Aphanocapsa*.

As is shown in Fig. 1, *Brachionus* had not only consumed *Aphanocapsa* that had accumulated radioactive elements to a considerable concentration but had, itself, accumulated radioactive elements from the culture water. In this case, where *Aphanocapsa* were consumed by *Brachionus*, only about 1 percent of the initial population density of the former remained after 120 hours. The breeding of *Brachionus* reached a maximum after 120 hours also, and these organisms suddenly perished owing to lack of food and sank to the bottom of the beaker. This aspect is illustrated by the dotted lines of Fig. 1. Corpses of *Brachionus* on the bottom of the beaker had concentrated about 65 percent of the radioactivity in the original culture water. However, after 288 hours, the radioactivity of the culture water had again increased owing to natural decomposition of the corpses.

The radiochemical group separations were carried out for the original culture water, *Aphanocapsa*, and corpses of *Brachionus* by use of an ion-exchange technique. After ashing in an electric furnace at about 600°C and treatment with HCl, samples were absorbed on an ion-exchange bed of Amberite 120 (30 to 60 mesh) and separated into each chemical group by the method of Thompkins (*6*). The samples of culture water were analyzed for $Sr^{90}(Y^{90})$, $Cs^{137}(Ba^{137m})$, and rare-earth elements and were found to have 30 percent, 15 percent, and 50 percent, respectively, of these chemicals. *Aphanocapsa* and corpses of *Brachionus* were also analyzed for each chemical group by the same method. The results of this series of experiments are shown in Fig. 2.

If the population density of *Aphanocapsa* could be increased and a species of phytoplankton found that accumulates Cs selectively, this limnological process might be of use in the decontamination of radioactive wastes.

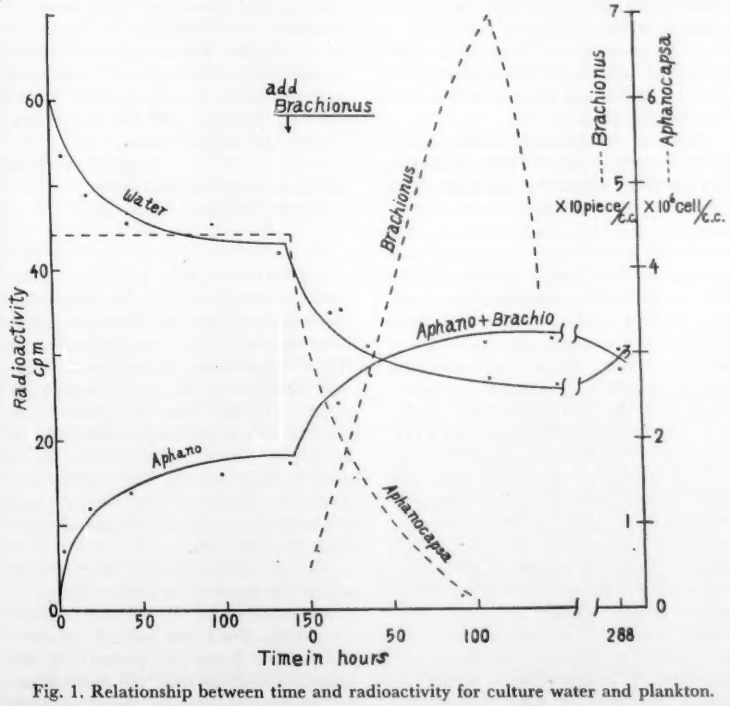

Fig. 1. Relationship between time and radioactivity for culture water and plankton.

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3 May 1956

Letters

The Planet Pluto

In view of the nature of the letter published under the title "Pluto not a planet?" [*Science* **123**, 896 (18 May 1956)], I wish to make the following statements.

Within the last year I have publicly discussed the origin of Pluto on two occasions, both incidental to a general discussion on the origin of the solar system: on 12 November 1945 for the Royal Canadian Institute at Toronto, and early last February at the National Science Foundation in Washington, D.C., at the Conference of Geophysics. The full text of the first talk is being published in three parts, two of which have appeared [*J. Roy. Astron. Soc. Can.*, Nos. 2, 3, 4 (1956)]. The Washington talk was briefer but was attended by a reporter from Science Service, who asked me a few supplementary questions on Pluto the next day. No other interviews were granted, although three or four further inquiries by telephone were answered. These facts show the absurdity of the first part of the letter of 18 May.

It may be that Science Service overemphasized the Pluto story in their release to the newspapers; at any rate, some silly headlines resulted. It seems ironical that my assistance rendered to Science Service should lead to the 18 May letter in *Science*. What is one to conclude from this for one's further conduct?

The comment was made that Lyttleton had already suggested Pluto's origin as a satellite of Neptune; this item is covered by my article. The explanation of Pluto's having been lost from Neptune by the almost complete evaporation of the protoplanet "should not be confused with Lyttleton's hypothesis that Pluto and Triton were initially both satellites of Neptune and then had a close encounter, which caused Pluto to leave the system and Triton to become retrograde. There is no reason to suppose that an encounter between regular satellites has ever occurred; and there are five retrograde satellites other than Triton." Two further articles on this problem, one by E. K. Rabe and one by myself, are in press, showing that the Jacobi constant of Pluto's orbit in the system Sun-Neptune confirms my hypothesis on the origin of Pluto and contradicts the earlier suggestion.

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22 June 1956

Secondary-School Science Teachers

John Mayor's editorial "Credit in education?" [*Science* **123**, 919 (25 May 1956)] should not pass unchallenged. There is probably general agreement regarding the need to prepare more teachers of science and mathematics, to induce the present teachers to remain in the teaching profession, and to improve the competence of those not adequately trained either in subject matter or in teaching techniques. Improved salaries, improved teaching facilities, and added prestige and status for the well-trained teacher will help.

Some of the assumptions expressed in the third paragraph of Mayor's editorial are especially disturbing. Since one of the present needs is to add to the feeling of competence of the teacher, this can best be met by added course work in the subject-matter field and, to some degree as well, by special courses in teaching problems in that subject matter. This need for added competence and the feeling of having obtained it are quite separate from the problem of whether the courses taken do or do not yield graduate credit.

I would urge that a part of the STIP program of the AAAS be devoted to promoting among school boards and any other controlling agencies, including legislatures when necessary, the notion that increased competence earned through taking appropriate courses be recognized and rewarded by increased salary. Since school boards already recognize such added competence as accrues from *present* graduate courses and *present* master's programs, I suggest that it would be grossly improper to mislead them by radically changing the "rules" regarding credit level. It would certainly be naive, at best, to assume that school boards and superintendents would be unaware of the changed quality and nature of the course work submitted, and they could be expected to react vigorously to the changes. Further, it is unlikely that a teacher will acquire more prestige next year by taking an introductory science course for graduate credit than by taking the same course today for undergraduate credit, even though the same courses offered for graduate credit might have "more satisfactory enrollments."

Colleges and universities, however, must not merely resist pressures to downgrade graduate credit in subject-matter and teaching-problems courses; they must also seize the opportunities to encourage prospective teachers. Where staff, student-body size, and finances permit, they should establish such subject-matter courses as may best help the teacher or prospective teacher (as the STIP recognizes).

There is one more imperative in this program. Since the high-school science teacher will, over the years, be the interpreter of scientific research to the largest part of his community, he must have some firsthand experience with research. This can be obtained through his own M.S. thesis work, or it can be obtained as a part of a research group concerned with faculty or other advanced graduate student work. Planning for this program must be a prime concern of our colleges and universities. Only when our secondary-school teachers can appropriately interpret science and scientists to our growing public will real respect and understanding of science come in this country. This, too, will add to the prestige of the science teacher.

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University of Iowa, Iowa City

The letter of Jerry J. Kollros is another encouraging indication of the genuine concern of scientists about the quality of science teaching in secondary schools. There is agreement on the part of scientists, of educationists, and of secondary-school teachers that a great many teachers of science and mathematics in secondary schools need added course work in subject matter. The disagreement comes, of course, on the best ways of meeting these needs, so well stated in the letter from Kollros.

All can also agree that the *need* for added course work in subject matter is quite separate from the problem of graduate credit. Here, the basis of disagreement arises from the question of the reasonableness, or even the desirability, of expecting teachers to meet this need by taking undergraduate courses in science. Salary schedules, based on graduate

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credit, present one deterrent. Registration in freshman and sophomore courses with much younger students, some of whom may be former students of the teacher enrollee, presents another. Questions, sometimes embarrassing, from colleagues and friends back home become still another. In our secondary schools, as in our colleges and universities, the degrees earned by a staff member are important to the teacher's status and, indeed, to his self-respect.

There is almost universal agreement that the status of teachers in the community and the recognition of the importance of their work for the national welfare should be generally enhanced. The National Education Association and other professional organizations of teachers are working toward the essential goal of the general recognition of teaching as a profession. Graduate credit and the master's degree provide objective evidence of professional and personal achievement. Although this may not be wholly dependable, these objective measures are in a sense comparable with the objective measure of grades earned, also not wholly dependable. Teachers should be encouraged to seek this kind of evidence, in addition to many other kinds of evidence, of their professional accomplishment.

No one seriously proposes that graduate credit be given to teachers for a regularly offered undergraduate course, particularly at the freshman or sophomore levels. If a teacher finds that he has been assigned to teach a physics class, and he has had no work in college physics, he should, in practically all cases, be required to take the first college course in physics. The teacher who has had some undergraduate work in physics, possibly a major in physics 20 years ago, or perhaps 10 or 15 hours in physics 2 or 3 years ago, is in a different situation. Quite a number of colleges and universities are finding it possible to offer special subject-matter courses in science and mathematics for teachers which carry graduate credit, usually to be counted only toward a master's degree in science teaching. Prerequisites for these courses include teaching experience and, usually, some undergraduate course work in the subject. Although the content might be of a scientific level lower than that in other graduate courses leading to the master's degree in the science and to research, it has still been found possible to offer such courses at a reasonably respectable level. The danger of "downgrading graduate credit in subject matter" by this practice seems to many less serious than the danger from a situation in which teachers, who may be weak in subject matter, continue to take all of their graduate work in education.

The Science Teaching Improvement Program has tried, and will continue to try, to promote the acceptance on the part of controlling and influential agencies at the national level of the principle "that increased competence earned through taking appropriate courses be recognized and rewarded by increased salaries," as is urged by Kollros. This activity has been supplemented by support and encouragement given to efforts to bring about the highly desirable goal of merit salary increases for teachers. As of 1 August 1955, there were 27,992 high schools in the United States. The influence of the Science Teaching Improvement Program directly on salary schedules of this very large number of schools is of necessity negligible. Scientists throughout the country can assist by making their views known to school boards in their own communities, and they can be encouraged in these efforts by the example of the good work now going on at the local level in the Washington area.

In disagreement with Kollros, it seems safe to assume that members of school boards and school administrators will readily accept the definition of graduate credit by colleges and universities. These people, devoted to the welfare of the schools, surely would welcome adjustment in traditional patterns of science offerings, which are planned specifically to increase the competence of their teachers. The change in quality and nature of the course work would be welcomed as a change to better quality for the particular job and need of their teachers.

The endorsement of Kollros of first-hand experience with research for secondary-school teachers is highly commendable. This sound proposal points out another way in which scientists in higher education can make a real contribution to the improvement of science teaching in our schools.

JOHN R. MAYOR
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Meriones

I have noted the article regarding a new laboratory animal, *Meriones libycus*, in *Science* [**123**, 790 (1956)]. The following information regarding other species of *Meriones* may be of some interest.

In 1952 at a Symposium on the Leptospiroses sponsored by the Veterinary Division, Walter Reed Army Institute of Research, Washington, D.C., J. Van der Hoeden reported that a rodent belonging to the group *Meriones* and native to Israel had been found to be extremely susceptible to infection with *Leptospira*. These rodents (*M. crassus sacramenti*) and the smaller type gerbil *M. shawi*) have been used in Van der Hoeden's laboratory for the isolation of *Leptospira* from suspected materials since 1950. In a recent report [*J. Infectious Diseases* **95**, 213 (1954)], Van der Hoeden recommended *M. crassus sacramenti* as a valuable test animal for both routine and research studies of *Leptospira*. Several pair of this species were obtained from Van der Hoeden's laboratory in Israel by the Leptospira Research Unit of the Communicable Disease Center in December 1954. Unfortunately, breeding has been unsuccessful.

A colony of *M. unguiculatus* has been established at Tumblebrook Farm, Brant Lake, N.Y., for commercial production. According to Floyd and Hoogstraal [*J. Hyg.* **52**, 516 (1954)] and others, the *Meriones* will breed under laboratory conditions, but the smaller gerbil (*Gerbillus pyramidium*) and the jerboa (*Jaculus orientalis*) do not breed in captivity.

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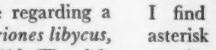
Crucifix and Dagger

Charles F. Richter's letter entitled "Dangerous dagger" [*Science* **123**, 723 (27 Apr. 1956)] confuses the crucifix with a dagger. Perhaps he could claim justification by referring to Louis IX of France, Saint Louis, who is said to have made his sword a cross by holding it aloft by the blade. I believe that American printing custom is to use first an asterisk as a reference mark and next the dagger (sometimes called an obelisk). The cross as used by the continental printers in obituary notes and to indicate posthumous publications has no relation to the religious beliefs of the deceased but is a mark of respect. Respect is certainly not implied by the American custom of putting "deceased" in a footnote. The continental printer's cross is not pointed like a dagger.

In the catalog of French monotype faces before me (Ets. J.-B. Abrate, 153, Boulevard de la Gare, Paris—XIII), I find neither the asterisk nor the dagger, but the cross is figured among the "signes" (see figure). Even in the small type size, the lower limb is not pointed. I have seen the pointed cross in German heavy (bold) Gothic type face titles, for letters and characters with a straight bottom do not exist in this type face. The same German pages will carry a regulation cross in the text, printed in a Roman type face.



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Book Reviews

Numerical Analysis. With emphasis on the application of numerical techniques to problems of infinitestimal calculus in single variable. Zdeněk Kopal. Wiley, New York, 1955. 556 pp. Illus. $12.

Numerical analysis is the science upon which the art of computing is based. Details of the art will vary with the computing device being employed—for example, abacus, slide rule, or Univac. However, the glamor of the electronic digital computers and their explosive propagation focus the attention on digital computation and lead to a restricted usage of the terms *computing* and *numerical analysis*. At any rate, most recent books whose titles include the words have little if anything to say about analog computers.

A digital device is designed to represent numbers as sums of powers of some base, in practice 2 or 10. Only a limited class of numbers can be represented exactly (for example, those expressible by ten decimal digits); others are only approximated. The device is further designed to perform only the four arithmetic operations, and the result can be exact in general only when it, as well as the operands, are all members of the limited class of numbers that are exactly representable. The output of a digital device is a finite set of numbers of the limited class. Thus a function, as such, is not a possible output, although a finite set of its functional values, or approximate values, would be.

Many problems of great practical importance, however (differential equations, integral equations), have a function, or several functions, among the unknowns. Such a problem must be somehow reduced so that a finite set of numbers will suffice. These numbers may be values of the function or functions at selected points. A somewhat more general approach is to set up a limited class of functions (polynomials, perhaps), which may or may not include a required function among its members, but from which one may hope to select a member that in some sense approximates the required function. The aforementioned reduction then amounts to finding a system of equations satisfied by those parameters which distinguish the approximating function (for example, the coefficients of an approximating polynomial) from among the others of its class.

Thus the problems for numerical analysis tend to stratify at two fairly distinct levels. At the higher, or secondary, level are the problems of reduction of functional equations to finite equations. At the primary level lie, however, the solution of these finite equations, along with the location of the extremes of functions, and the approximation of functions of rather general classes by functions of some fairly restricted class.

The areas concerned with equations, extremes, and approximations are not wholly distinct. In fact, the approximating function may be designated by parameters that satisfy a given set of equations, or minimize a given function, or both. Thus a separation is rather artificial, and reasonable justice can hardly be done to any one topic without some discussion of the other. Certainly a treatment of one of these topics to the exclusion of the others can scarcely justify being called "numerical analysis" without some qualification.

Nevertheless, Kopal's book, in spite of the general title, is in fact so restricted. It is true that the longish subtitle, which few will remember, gives warning that the contents are less general than the title. But even this, while excluding matrix theory and systems of equations, leaves open the possibility for including a consideration of the zeros and poles of functions of a single variable.

The book deals exclusively with polynomial interpolation, numerical differentiation and integration, and orthogonal polynomials, at the primary level; and, at the secondary level, with ordinary differential equations, including both initial-value problems and boundary-value problems, and with integral equations. An appendix discusses the use of Chebyshev polynomials for optimum-interval interpolation, but Chebyshev approximation (minimal departure) is not discussed.

Within the limited area there is, indeed, a great deal of material in the book. A brief history of numerical analysis provides an interesting introduction. Thereafter, two chapters on polynomial interpolation and numerical differentiation are followed by three on differential equations; and a chapter on mechanical quadrature is followed by one on integral equations. Noteworthy features are the sections on error in Chapters II and IV, the treatment of Runge-Kutta methods, the discussion of mechanical quadrature, the appendix on Chebyshev polynomials, the numerous problems, and the bibliography and notes.

The treatment is certainly not that of a mathematician; it is often prolix, sometimes confusing, and generally uninhibited by undue concern for rigor. As so often in books on the subject, the emphasis is on recipes and not principles. The phraseology is occasionally bizarre. Thus we are told that numerical analysis does not know of irrationals.

Problems in an area not treated are sometimes shrugged off as trivial. Thus, in the treatment of boundary-value problems, the author is careful to keep the matrices of low order, and we are told that (p. 284) once the characteristic values are known "the corresponding characteristic functions can be constructed without difficulty." The author then proceeds to "demonstrate the fact" by an example!

In brief, this is an excellent reference covering a limited area and might make a good textbook within that area, provided that it is consulted with circumspection or presented by an instructor who will fill the gaps.

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Combustion Processes. vol. II, **High Speed Aerodynamics and Jet Propulsion.** B. Lewis, R. N. Pease, and H. S. Taylor, Eds. Princeton University Press, Princeton, N.J., 1956. 662 pp. Illus. + plates. $12.50.

The purpose of this series and, in particular, of this volume is perhaps best expressed by the following quotations from the series editor and the volume editor. "Rapid advances made during the past decade on problems associated with high speed flight have brought into even sharper focus the need for a comprehensive and competent treatment of the fundamental aspects of the aerodynamic and propulsion problems of high speed flight." [This volume] "deals with rate processes in chemical reactions, the propagation of chemical reaction by the mechanism of combustion waves and detonation waves, with the effect of turbulence on combustion waves, with processes of simultaneous mixing and combustion of fuels and oxidants and with chemical equilibria."

One of the obvious difficulties confronting the volume editors was that there was already in existence an excellent book covering an important part of the subject written by one of their members. This problem was ingeniously solved by including "a condensed version of Chapter VII of the authors' [B. Lewis and G. von Elbe] book *Combustion Flames and Explosions of Gases.*" I would like to commend the editors on this decision; the material, which constitutes 96 out of the total of 662 pages, is certainly well worth repetition and, in fact, is a high point of the volume.

Another difficulty faced by the editors is the great diversity in the kind of material necessary to cover the subject. This material ranges from relatively simple and well-understood phenomena where theoretical analysis is powerful and useful to subjects so complicated and poorly understood that a survey of the state of the art is about all that can be accomplished. In general, the multiplicity of authors and corresponding points of view offers an acceptable solution to this problem, although it raises others. One finds, for example, that the author and the subject matter are not always ideally suited.

I found my blood pressure rising slightly when I discovered on page 27 that the outmoded and confusing concept of "friction work" is perpetuated. A subsequent author finds it necessary to square himself with the "friction work" concept by a footnote (page 208), which says: "Here, as is always the case, heat and heat flow are defined so as to complete the energy balance. A modification of the definition of work must be accompanied by a corresponding modification of the definition of heat flow." It is regrettable that such a footnote was necessary.

On pages 346 to 351, a section appears entitled "Turbulence generation by a turbulent flame" in which the author states that, "The intensity of the turbulence generated by the flame may be calculated from the amount of mechanical work developed by the gas as it flows across the pressure drop Δp of the instantaneous flame front *because* this work is the source of additional turbulent energy." (Italics are mine.)

The author notes that the work done by the expanding gas on the surroundings is not equal to $\int p d\left(\frac{1}{\rho}\right)$ and concludes that the discrepancy is the source of turbulence. If this were true, then it would follow that the flow behind any shock wave, where the same discrepancy exists, would show strong turbulence (which it does not). I suggest that it is necessary to look elsewhere for the source of flame-generated turbulence. It appears that the fundamental difficulty here is the failure to distinguish clearly between a flow process and a batch process, between a control volume and a system, between the Eulerian and the La Grangian point of view, however you wish to state it. It is unfortunate that the fine treatment of this problem which appears on pages 203 to 211 is concealed in mathematical symbolism that is unfamiliar to many people.

I am puzzled by the statement on page 211: "Since the theory of irreversible processes is considered in I, J . . ." Does this refer to sections I and J of this volume? A search of these sections and the index fails to show anything of the "theory," or is this perhaps more mathematical symbolism?

The foregoing criticisms are not to be taken as a general comment on what is generally a fine contribution to the literature on combustion. They are more an expression of my perverse delight in finding minor flaws in so formidable a volume.

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Advances in Electronics and Electron Physics. vol. VII. L. Marton, Ed. Academic Press, New York, 1955. 527 pp. Illus. $11.50.

This volume fully lives up to the very high standards its predecessors have set, and once again the editor has managed to cover a wide variety of topics. The seven contributions to this volume are on the physics of semiconductivity (Burstein and Egli), the theory of the electric properties of Ge and Si (Brooks), characteristic energy losses of electrons (Marton, Leder, and Mendlowitz), sputtering (Wehner), radio astronomy (Wild), analog computers (Vance, Hutter, Lehman, and Wadlin), and electric discharges (Goldstein).

In the first article a thorough survey is given of the experimental data now available on all kinds of semiconductors. The accent is on empiricism and on comparing the various materials. The second article deals with semiconductor theory, especially as applied to Ge and Si. Special attention is paid to scattering mechanisms and optical properties and to recent information about energy band structure. I was rather sorry not to find in this otherwise excellent survey any mention of the recent work on the many-electron model or the polaron model of semiconductors and also hardly any mention of the vast amount of Russian literature—which, unfortunately, is, of course, very difficult to obtain. However, it seems to me that the present state of detailed experimental knowledge makes it necessary to investigate and probably drastically change the basic ideas of semiconductor (and metal) theory rather than change only in detail the 1-electron picture which was adequate, when it was first proposed by Sommerfeld, to a large extent because of the paucity of experimental data.

The third article presents us with a welcome survey of the vast amount of data assembled in the last few years on characteristic energy losses of electrons in solids. It also shows us how far the theoretical interpretation still leaves a lot to be desired. Indeed, one of the greatest virtues of this series of volumes is to my mind their stimulating value to both experimenters and theorists.

The article on sputtering also presents us with a beautiful array of experimental data and with a conclusion that no theory presented up to now has been able to explain the facts. In the article on radio astronomy the experimental point of view is to my mind pushed too far. A few more explanations of the why and wherefore would have been welcome. For instance, the reader might have been told *how* the hydrogen density distribution in our galaxy is determined from the 21-cm line profile.

Analog computers, their construction, components, and use in flight simulation, physics, mathematics, biology, industrial processes, and business and economics are discussed in the next contribution, while a survey of recent developments in the investigation of electric discharges concludes this volume. This last article limits itself to a discussion of the experimental methods that leave the discharge virtually undisturbed and, within its limitation, gives a comprehensive picture. Here also, the way is pointed to further experimental and theoretical research.

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Structure Reports for 1942–1944. vol. 9. A. J. C. Wilson, General Ed. N. C. Baenziger, Ed. for metals; J. M. Bijvoet, Ed. for inorganic compounds; J. M. Robertson, Ed. for organic compounds. Published for the International Union of Crystallography. Oosthoek's Uitgevers MIJ, Utrecht, Netherlands, 1955. 448 pp. Fl. 65.

This volume reduces the gap between *Structurbericht,* 1913 to 1939, and the *Structure Reports* already published, which cover the period 1945 to 1950 in volumes 10 to 13. As in the previous volumes, the reports are distributed in three sections, metals, inorganic compounds, and organic compounds, and an attempt is made to include all the essential structural information relating to solids,

liquids, and gases published in the period. Not unnaturally, there tends to be a somewhat greater emphasis on the results of investigations on crystalline solids than on the electron diffraction of gases, for example. For the crystal structures it is certainly true that it is often not only more convenient but also more informative to read the *Structure Report* than the original paper, for the very competent reporters have not only extracted the essentials but have not hesitated to use their critical faculties where necessary. They have also taken advantage of the previously published reports to refer forward, when it is known that later work on the same structure has been accomplished.

The form of presentation of the data maintains the excellent standards set by the previously published volumes. Without question the whole series of *Structure Reports* is indispensable to the library of every institution or organization where there is an interest in the structure of matter. This volume is somewhat more expensive for its size than the previous ones because the cost of production is no longer subsidized. While it is proper that the price should be set to recover the cost, this fact will be accepted ruefully by crystallographers who agree with me that *Structure Reports* is also indispensable on their own private bookshelves.

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American Foundations and Their Fields. Wilmer Shields Rich. American Foundations Information Service, New York, ed. 7, 1955. xlvii + 744 pp. $35.

A new and excellent directory to a field in which one is interested can always provide fascinating browsing opportunities before it is put on a handy shelf ready for later use. The seventh edition of *American Foundations and Their Fields* is a good example. For each of 4162 foundations it gives the address, legal structure, date of establishment, donor, purpose, character of the gift that established the foundation, limitations on the use of funds, methods and policies regarding grants, current fields of interest, nature of grants, and officers and trustees, or as many of these items of information as were available or pertinent.

The foundations included are those that qualify "in the American understanding of the term: that is to say, one which is a nonprofit, legal entity having a principal fund of its own, or receiving the charitable contributions of a living founder or founders, which is governed by its own trustees or directors and which has been established to serve the welfare of mankind." Excluded are some organizations that include the word *foundation* in their titles, for the directory does not cover foundations that solicit for endowment, those created for the benefit of a single institution or group, those governed by some other institution, and those whose activities are restricted to the furnishing of a clinical or other community service.

The directory is incomplete. It could not be otherwise with the number of foundations increasing as rapidly as it is. Of the 4164 described, only ten were established before 1900, 2502 were established between 1940 and 1949, and 814 were established in 1950 or later. The author estimates that there may be as many as 7300 foundations that meet the definition given in the preceding paragraph.

In addition to the details available on individual foundations—from the Ford Foundation and the other big ones to the Stuart "Four-Square" Fund (with assets of $25,847), the Vanguard Fund (with assets of $3712), and hundreds of other small ones—there are tables and sections showing such things as geographic distribution, size distribution, number and location of community foundations and trusts, different types of organization, suggestions on how to prepare a request to a foundation, and sample legal forms for establishing a foundation.

The basic organization is by states. An alphabetical list of names serves as an index if the location of the principal office is not known. An index of fields identifies foundations interested in each of a number of fields, from *accounting, aesthetics,* and *Africa* to *youth* and *zoology.*

The first guide to American foundations was prepared by the Twentieth Century Fund for its own use. But the information was of such obvious value to others that the Twentieth Century Fund published three such directories between 1931 and 1935. The next three in the series were published by Raymond Rich Associates in 1939, 1942, and 1948. The seventh edition is the first to appear under the auspices of American Foundations Information Service. It continues and extends a valuable reference service. —D. W.

New Books

Die Pathologie des Kindlichen Pankreas. Gerhard Seifert. Thieme, Leipzig, 1956. 151 pp. DM. 52.

Determination of Organic Compounds. K. G. Stone. McGraw-Hill, New York, 1956. 233 pp. $5.

Numerical Analysis. Proceedings of symposia in applied mathematics. vol. VI. John H. Curtiss, Ed. McGraw-Hill, New York, 1956. 303 pp. $9.75.

On the Early Development of Mind. Selected papers on psycho-analysis. vol. I. Edward Glover. International Universities Press, New York, 1956. 483 pp. $7.50.

Child Development and Personality. Paul H. Mussen and John J. Conger. Harper, New York, 1956. 569 pp. $6.

Epilepsy and the Law. A proposal for legal reform in the light of medical progress. Roscoe L. Barrow and Howard D. Fabing. Hoeber-Harper, New York, 1956. 177 pp. $5.50.

Nuclear Fuels. David H. Gurinsky and G. J. Dienes. Van Nostrand, Princeton, N.J., 1956. 364 pp. $7.50.

Handbook of South American Geology. An explanation of the geologic map of South America. Geological Society of America Mem. 65. W. William F. Jenks, Ed. Geological Society of America, New York 27, 1956. 378 pp.

Anatomy of the Honey Bee. R. E. Snodgrass. Comstock Division of Cornell University Press, Ithaca, New York, 1956. 334 pp. $6.

Atoms and Energy. H. S. W. Massey. Philosophical Library, New York, 1956. 174 pp. $4.75.

Miscellaneous Publications

(Inquiries concerning these publications should be addressed, not to Science, *but to the publisher or agency sponsoring the publication.)*

Experimental Treatment of Tumors in Mice. Floyd C. Turner. The Author, Box 807, Boulder Creek, Calif. 1956. 117 pp.

Symposium on Structure of Enzymes and Proteins. Given at Research Conference for Biology and Medicine of the Atomic Energy Commission. Sponsored by the Biology Division, Oak Ridge National Laboratory, Gatlinburg, Tenn., Apr. 4–6, 1955. Oak Ridge National Laboratory. Wistar Institute of Anatomy and Biology, Philadelphia, 1956. 294 pp. (Reprinted from *Journal of Cellular and Comparative Physiology,* vol. 47, Suppl. 1)

Vibration and Stresses in Girder Bridges. Highway Research Board Bull. 124. 134 pp. $2.55. *The Biological Effects of Atomic Radiation.* Summary reports. 108 pp. *The Biological Effects of Atomic Radiation.* A report to the public. 40 pp. National Academy of Sciences–National Research Council, Washington 25, D.C.

Australian and New Zealand Association for the Advancement of Science. Report of the 30th meeting, Canberra; Jan. 1954. C. S. Daley, Honorary Ed. Australian and New Zealand Association for the Advancement of Science, Sydney, Australia, 1955. 370 pp. Illus.

The Examination of New Organic Compounds. Macro and semimicro analytical methods. A laboratory manual. Walter T. Smith, Jr., and Ralph L. Shriner. Wiley, New York; Chapman & Hall, London, 1956. 136 pp. $3.50.

Technion Yearbook, vol. 13. 1956 ed. American Technion Society, New York 28, N.Y., 1956. 203 pp.

Meetings and Societies

Quantum Interactions of the Free Electron

On 23–25 Apr. an International Conference on Quantum Interactions of the Free Electron was held at the University of Maryland. Approximately 200 persons from some nine countries (Canada, England, France, Germany, Italy, Japan, the Netherlands, Norway, and the United States) attended. The conference was held in commemoration of the 100th anniversary of the birth of J. J. Thomson—the discoverer of the electron—and in conjunction with the centennial and sesquicentennial celebrations of the University of Maryland. The conference was sponsored by the International Union of Pure and Applied Physics (organized with the financial help of UNESCO), the National Science Foundation, the Office of Naval Research, the Air Research and Development Command, the University of Maryland, and the National Bureau of Standards.

Nine invited papers were the basis for discussion as well as the main business of the conference. These can be roughly grouped into two categories: use of electrons, both positive and negative, as probes for studying properties of matter and interference properties of electrons. Using the new high-resolution velocity analyzers for electrons—for example, the Möllenstedt lens—it is now possible to discern characteristic energy losses of electrons on passing them through thin solid foils. There was much discussion regarding the mechanism of these losses, whether they may result from band-band transitions or from the excitation of plasma or collective oscillations. It would appear that both occur and that further studies will reveal which mechanism is associated with which loss, thereby giving considerable information about the energy-level structure of solids, just as the old Franck-Hertz experiments did for atoms in gases. The Stanford work on the scattering of high-energy electrons from nuclei was reported, showing again the usefulness of the electron as a probe. This work not only has established the radii of many nuclei, but also, and perhaps of greater fundamental importance, has shown that the proton has a finite radius of approximately 10^{-13} centimeters.

A paper on the polarization of electrons showed that, just as the energy losses of electrons provided information about matter, so might an analysis of their polarization. So far, the experimental technique is still being developed, and most of the effort is devoted to verifying the theory by double-scattering techniques and to measurements of the gyromagnetic ratio of the free electron. The measurement of the gyromagnetic ratio of the free electron is quite interesting, inasmuch as it was felt by some just a few years ago that this was forbidden by the uncertainty principle.

Two papers were given on the interaction of positrons with matter—one concerned mainly with the experimental phenomena; the other, with their interpretation. Positrons have a distinct advantage over most other probes in that they transmit their information by means of γ-rays that are little attenuated by passage through the material. By observing the angular correlation of the annihilation γ-ray, one learns about the momentum distribution of the electrons in solids and liquids. For conductors and semiconductors, this is in surprisingly good agreement with that of the Fermi-gas of free electrons, except for wings on the distribution, which are probably due to annihilation with core electrons, while, for ionic crystals the distribution appears triangular rather than parabolic. The results on the annihilation lifetimes are more puzzling, especially the temperature dependence which decreases with decreasing temperature. Lifetime measurements indicate positronium formation in many solids and liquids. The conditions for this are not yet known, although it is clear that certain energy and geometric conditions—for example, sufficient interstitial volume for a positronium atom—must be satisfied.

The state of the art on electron interference and the conditions under which it occurs was described in two invited papers and in a long discussion by Uyeda. Electron interference has been observed, using arrangements similar to the Mach interferometer (the Bureau of Standards group) and Fresnel biprism (Tübingen group). There was considerable discussion of the meaning of coherence length for electrons and the role played by the dispersive nature of the vacuum for electron waves.

A highlight of the conference was the banquet with its after-dinner speakers, George Thomson, son of J. J. Thomson and himself a Nobel laureate for his work on the wave nature of the electron, and K. K. Darrow, secretary of the American Physical Society. Thomson reminisced about his father and the work at the Cavendish Laboratory. Darrow recalled other great names and milestones in the history of the electron.

The invited papers, which will appear in a forthcoming issue of *Reviews of Modern Physics*, were as follows: "Experiments on low-energy scattering and energy losses," L. Marton (National Bureau of Standards); "Collective energy losses in solids," D. Pines (Princeton University); "Theory of electron scattering," H. S. W. Massey (University of London); "High-energy electron scattering," R. Hofstadter (Stanford University); "Electron interference experiments," J. A. Simpson (National Bureau of Standards); "Theory of electron interference experiments," D. Gabor (Imperial College, London); "Electron polarization, theory and experiment," H. A. Tolhoek (University of Leiden, Holland); "Experimental studies of positron interactions with matter," S. Berko and F. L. Hereford (University of Virginia); "Theory of positron interactions with matter," R. Ferrell (University of Maryland).

It is to be hoped that the success of this, the first international conference in the field of the interactions of the nearly free electron, will lead to future conferences. The importance of opportunities for personal discussions and exchange of ideas can hardly be overemphasized.

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Science and the Modern World View

In honor of physicists P. W. Bridgman and Philipp Frank, who have now retired from active teaching at Harvard University, a conference was held in Cambridge, Mass., on 5 and 6 May. The general topic was Science and the Modern World View—Toward a Common Understanding of the Sciences and the Humanities, and sponsorship came from the American Academy of Arts and Sciences, the Institute for the Unity of Science, and the National Science Foundation.

(Back row) Charles Morris, Nathan M. Pusey, J. R. Oppenheimer, John E. Burchard, Perry Miller, H. M. Jones, and Harcourt Brown. (Front row) G. Holton, I. I. Rabi, Detlev W. Bronk, P. W. Bridgman, Philipp Frank, W. V. Quine, and Giorgio de Santillana.

As scientists and philosophers, as teachers, colleagues and friends, Bridgman and Frank have both been enlightening and stimulating to scholars in many fields and in many countries. While their respective contributions lie in different areas, they share this characteristic: through his work each has gained wide respect among scientists and humanists, whether these have always agreed or (as perhaps was sometimes intended) by disagreement have been stimulated to further discussion. Thus the topic of the conference reflected the fact that the region of interest in which both men overlap is not any single scientific or philosophic problem, but the eloquent and persistent exposition of a broad view of science and the world. Throughout their philosophic writings, they have drawn attention to the need for unifying our universe of knowledge. They both have pointed to possible methods for escaping the process of fragmentation which, many feel, lies at the basis of the contemporary crisis of our culture, the separation of the sciences and humanities.

Both Frank and Bridgman of course refused to sanction a ceremonial *Feier,* and at their request none of the papers was devoted specifically to their work; rather, it was the occasion and the character of the meeting which honored them. In fact, they both agreed to participate actively.

The three sessions were arranged to examine the relation between the sciences and the humanities in chronological sequence. In session A, entitled "On the interaction of the sciences and humanities," a group of humanists examined a case history, namely, the manner in which the rise of science in the 17th century affected the culture and world-view of the 18th century. The main participants were John E. Burchard (M.I.T.), Ernest Nagel (Columbia), Giorgio de Santillana (M.I.T.), Henry Guerlac (Cornell), Harcourt Brown (Brown), and Perry Miller (Harvard).

Session B concerned itself with "Modern science and the basic conceptions of our present world view." Specific attention was directed toward key concepts of science which have undergone profound changes in the last two or three generations, and the conflict implied between the new conceptions and the old bases of the current world view. The main participants were I. I. Rabi (Columbia), P. Frank, Robert Oppenheimer (Institute for Advanced Study), Jerome S. Bruner (Harvard) and W. V. Quine (Harvard).

"Prospects for a new synthesis" was the title of session C, which looked for possible roads toward a common understanding between scientists and humanists. This was of particular interest to those of us who are puzzled and disturbed by the opinion, apparently held by some leading thinkers, that modern science and the humanities have inevitably conflicting and mutually detrimental roles in our culture. The participants were Detlev W. Bronk (Rockefeller Institute), P. W. Bridgman, Charles Morris (Chicago), H. M. Jones (Harvard) and Susanne K. Langer (Connecticut College).

An invited audience of about 250 persons aided in the discussion following the formal presentation of each session. The gathered proceedings, including concise statements of significant parts of the discussion, are being edited by the undersigned, who acted as chairman of the conference committee. Publication in book form is expected in a few months.

GERALD HOLTON
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Fertility and Sterility

The world famous bay area of Napoli in Italy near the foothills of Pompei was the meeting place of the second world congress on fertility and sterility, 18–26 May, sponsored by the International Fertility Association. Twelve hundred doctors (obstetricians, gynecologists, veterinarians and biologists) from 63 nations (including the U.S.S.R.) participated. The meeting was the largest ever held in the area of reproduction, and Giuseppe Tesauro (University of Napoli) performed a most commendable job in handling the local arrangements. A total of 352 scientific papers were listed on the program, but approximately 5 percent of the papers were not presented, mainly owing to the inability of certain investigators to attend.

The scientific program was divided into 15 sections: endocrine, metabolic, and hematologic factors in fertility and sterility; endocrine therapy in female sterility; diagnosis of ovulation and its disorders; treatment of disorders of ovulation; tubal physiology and its disorders; evolution of new methods of diagnosis and medical treatment of female sterility; occupational, toxic, and psychological factors in fertility and sterility; surgery in treatment of female sterility; experimental and clinical investigations

in female sterility; diagnosis of spermatogenesis and its disorders; treatment of disorders of spermatogenesis; new methods of diagnosis of male sterility; surgery in male sterility; and problems in animal production.

Since the program covered a wide range of subjects and was overcrowded with papers, it was difficult to have an open discussion on points that were somewhat obscure or poorly translated. More important and extremely informative were the round-table discussions and the invited lectures.

Two of the most outstanding lectures were delivered by B. Bernard Weinstein and Bernhard Zondek. Weinstein presented a thorough analysis of the medical status in the sterile couple in 1956. It is gratifying to know that the clinician has focused his attention on the basic concepts of sterility hitherto not investigated and, in so doing, has helped previously designated "sterile" couples to have children. According to statistics provided by Weinstein it seems that at least 20 percent of "sterile" couples have been helped medically and are now parents of children. Zondek lectured on the functional significance of the cervical mucus. His presentation clarified a number of doubts relative to the validity of the correlation between the cervical mucus and the status of the menstrual cycle.

Scientists have long been engaged in controversies when only a few facts were available, and this congress was not an exception. The round tables were highly controversial, and, after listening to a few of them, one got the distinct impression that the biology of reproduction is a young field loaded with activity for a whole century of biologists as well as specialists.

The population problem—or any phase of it including artificial insemination—was not covered at this congress. In this connection, it should be mentioned that the congress was addressed in Vatican City by Pope Pius XII, and the entire congress was told that "artificial insemination contravenes ethics and nature" [see *L'Osservatore Romano*, 20 May 1956, p. 1, and the *New York Times*, 20 May 1956, p. 14].

The congress accomplished its main goal: the dissemination of "tried and true" clinical practices, new clinical procedures, views on existing defective techniques, and basic information derived from recent experiments. True, not all papers reported new advances, but on the whole the exchange of scientific ideas among representatives from 63 nations proved interesting.

Two factors that displeased most attendants were the large number of papers and the lack of abstracts at the meetings. It was a general attitude that some of the papers should not have been given, especially since they lacked scientific methodology, clinical acumen, information, originality, and progress. Some of the papers reviewed past researches with little added that was new.

Unfortunately, the publication of the abstracts and the papers will take at least one full year. The papers will be published in a volume entitled, *The Second World Congress on Fertility and Sterility*. This is a distinct disadvantage, inasmuch as a more practical system could be devised. There is no reason whatsoever why the abstracts could not be issued at the time of the meetings, a practice followed in the United States. The third world congress on fertility and sterility will take place in Amsterdam.

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Meeting Notes

■ The American College of Cardiology will hold its fifth interim meeting at the Webster Hall Hotel, Pittsburgh, Pa., 28–30 Nov. The general topic of the meeting will be coronary artery disease and myocardial infarction, and symposia will be held on diagnosis, recent trends in medical and surgical therapy, industrial and compensation aspects, and rehabilitation and medicolegal problems. Simon Dack, of New York, will preside jointly with William McElroy, dean of the Medical School of the University of Pittsburgh. Various members of the staff of the university's medical school will participate actively in the scientific sessions.

■ The third International Automation Exposition will be held at the New York Trade Show Building, New York City, 26–30 Nov. A wide variety of products for plant and office will be displayed, from automatic assembly, handling, and data-processing equipment to subminiature relays and switches. Each morning lecture-demonstrations will be given on computers, process automation, machine automation, servomechanisms, and electromechanical and electronic components. Conferences on office automation and on human engineering and automation will be sponsored, respectively, by the Fordham University School of Business and by the Manhattan College School of Engineering. For information write to Richard Rimbach Associates, Inc., 845 Ridge Ave., Pittsburgh 12, Pa.

■ The first of a series of three symposia dealing with the historical development of physiological thought in the medical sciences will be held at the State University of New York College of Medicine in Brooklyn, N.Y., on 13–15 Nov. The speakers and subjects will be Owsei Temkin, "The dependence of medicine upon basic scientific thought"; Iago Galdston, "Physiology and the recurrent problem of vitalism"; Lloyd G. Stevenson, "The structural basis of function and anatomical reasoning in physiological thought"; Horace W. Magoun, "Development of ideas relating the brain with the mind"; Chauncey D. Leake, "Development of knowledge of the cardiovascular system."

Society Elections

■ American Society of Agricultural Engineers: pres., Roy Bainer, University of California; sec., J. L. Butt, American Society of Agricultural Engineers, Saint Joseph, Mich. The vice presidents are P. T. Montfort, Agricultural and Mechanical College of Texas; H. J. Barre, Mansfield, Ohio; H. H. Beaty, Edison Electric Institute. Representative to the AAAS Council is Harold Pinches, U.S. Department of Agriculture.

■ Pacific Division of the American Association for the Advancement of Science: pres., J. Murray Luck, Stanford University; pres. elect, Ian Campbell, California Institute of Technology; sec. and representative to the AAAS Council, Robert C. Miller, California Academy of Sciences, San Francisco.

■ Technical Writing Improvement Society: pres., John L. Kent, Consolidated Electrodynamics Corp.; v. pres., Herbert Michaelson, Sylvania Electric; sec., Faith Kildare, Western Technical Writing Institute, Box 42041, Los Angeles 42, Calif.; treas., George A. Whittington.

■ Society of Nuclear Medicine: pres., N. J. Holter, Helena, Mont.; v. pres., Henry Turner, Oklahoma City; pres. elect, Franz Bauer, Los Angeles; sec., Robert Lackey, Denver; treas., Linden Seed, Chicago.

Forthcoming Events

September

15–23. **Instruments and Measurements, 4th intern. conf. and exhibition, Stockholm, Sweden. (S. Malström, P. O. Box 36, Stockholm 12.)**

16–21. **American Chemical Soc., Atlantic City, N.J. (A. H. Emery, ACS, 1155 16 St., NW, Washington 6.)**

16–22. **American Soc. for Testing Materials, Pacific Coast meeting, Los Angeles, Calif. (R. J. Painter, ASTM, 1916 Race St., Philadelphia 3, Pa.)**

17–19. **Alpine Meteorology, 4th intern.**

cong., Chamonix, France. (Dr. Piery, Institut de Meteorologie et des Sciences des Climats, 72 Rue Pasteur, Lyon, France.)

17–21. Illuminating Engineering Soc., annual, Boston, Mass. (A. D. Hinckley, IES, 1860 Broadway, New York 23.)

17–21. Instrument Soc. of America, 11th international conf., New York, N.Y. (F. J. Tabery, 250 W. 57 St., New York 19.)

17–21. Theoretical Physics, intern. cong., Seattle, Wash. (J. H. Manley, Dept. of Physics, Univ. of Washington, Seattle 5.)

17–22. International Astronomical Federation, 7th cong., Rome, Italy. (J. A. Stemmer, IAF, P. O. Box 37, Baden, Switzerland.)

17–23. European Confederation of Agriculture, 8th general assembly, Sheveningen, Netherlands. (M. Collaud, ECA, Pestalozzistrasse 1, Brugg, Argovie, Switzerland.)

19–23. International Cong. of Internal Medicine, 4th, Madrid, Spain. (C. Jimenez Diaz, Facultad de Medicina, Madrid.)

20–21. Physical Chemistry of Processes at High Pressures, general discussion, Faraday Soc., Glasgow, Scotland. (F. C. Tompkins, Faraday Soc., 6 Gray's Inn Sq., London, W.C.1, England.)

21–22. Pharmacotherapy in Mental Illness, Washington, D.C. (J. O. Cole, National Research Council, 2101 Constitution Ave., NW, Washington 25.)

21–28. History of Medicine, 15th cong., Intern. Soc. for the History of Medicine, Madrid and Salamanca, Spain. (Luis S. Granjel, Instituto Arnaldo de Vilanova de Historia de la Medicina, Duque de Medinaceli, 4, Madrid.)

23–26. International Bureau of Differential Anthropology, 4th cong., San Remo, Italy. (Bureau International d'Athropologie Differentielle, Institut d'Anatomie de Université Ecole de Medicine, Geneva, Switzerland.)

24–25. Industrial Electronics Symposium, 5th annual, Cleveland, Ohio. (C. F. Schunemann, Thompson Products, 2196 Clarkwood Rd., Cleveland 3.)

24–26. American Oil Chemists' Soc., Chicago, Ill. (Mrs. L. R. Hawkins, AOCS, 35 E. Wacker Drive, Chicago 1.)

24–26. Biochemistry of Lignin, 3rd round table, Appleton, Wis. (H. F. Lewis, Inst. of Paper Chemistry, Appleton.)

24–27. Science of Photography, international conf., Cologne, Germany. (W. Schürmeyer, Hohenstaufenring 48/54, Cologne.)

24–28. International Dairy Cong., 14th, Rome, Italy. (R. E. Hodgson, Dairy Husbandry Research Branch, U.S. Dept. of Agriculture, Beltsville, Md.)

24–29. International Scientific Film Assoc., 10th cong., Vienna, Austria. (Secretariat of Intern. Assoc., 38, Ave. des Ternes, Paris 17, France.)

25–27. Atomic Industrial Forum and Trade Fair, 3rd annual conf., Chicago, Ill. (C. Robbins, AIF, 260 Madison Ave., New York 16.)

25–28. American Roentgen Ray Soc., annual, Los Angeles, Calif. (B. R. Young, Germantown Hospital, Philadelphia 44, Pa.)

25–28. Assoc. of Iron and Steel Engineers, annual, Cleveland, Ohio. (Secretary, AISE, Empire Bldg., Pittsburgh 22, Pa.)

25–29. Atmospheric Condensation Nuclei, 2nd intern. symp., Basel and Locarno, Switzerland. (M. Bider, Astronomical Meteorological Station, Basel, Switzerland.)

25–29. Automatic Controls, international conf., Univ. of Heidelberg, Germany. (R. Oldenburger, Woodward Governor Co., Rockford, Ill.)

26–28. The Direction of Research Organizations, intern. symp. Teddington, England. (National Physical Laboratory, Teddington, Middlesex, England.)

26–28. Mississippi Valley Medical Soc., annual, Chicago, Ill. (H. Swanberg, 510 Maine St., Quincy, Ill.)

26–29. European Cong. of Allergology, 3rd, Florence, Italy. (U. Serafini, Instituto di Patologia Medica, Viale Morgagni, Florence.)

27. Atomic Energy in Economic Development, Washington, D.C. (C. Allardice, International Bank for Reconstruction and Development, 1818 H St., NW, Washington 25.)

27–30. Alaskan Science Conf., 7th annual, Juneau. (H. C. Baltzo, U.S. Fish and Wildlife Service, Juneau.)

28–29. American Medical Writers' Assoc., annual, Chicago, Ill. (H. Swanberg, 510 Maine St., Quincy, Ill.)

28–29. Chemistry of Lignin, Polysaccharides and Related Substances, symp., Tucson, Ariz. (Dept. of Chemistry, Univ. of Arizona, Tucson.)

28–29. International Professional Union of Gynecologists and Obstetricians, 1st cong., Madrid, Spain. (J. Courtois, St. Germain-en-Laye, Seine-et-Oise, France.)

30. American College of Dentists, annual, Atlantic City, N.J. (O. W. Brandhorst, 4221 Lindell Blvd., St. Louis, Mo.)

30–4. Electrochemical Soc., Cleveland, Ohio. (H. B. Linford, 216 W. 102 St., New York 25.)

October

1–2. American Soc. of Photogrammetry, semiannual, Denver, Colo. (C. E. Palmer, ASP, 1515 Massachusetts Ave., NW, Washington 5.)

1–3. Institute of Radio Engineers, Canadian convention, Toronto, Canada. (G. Sinclair, Electrical Engineering Dept., Univ. of Toronto, Toronto.)

1–3. National Electronics Conf., 12th annual, Chicago, Ill. (NEC, 84 E. Randolph St., Chicago 1.)

1–4. American Dental Assoc., annual, Atlantic City, N.J. (H. Hillenbrand, ADA, 222 E. Superior St., Chicago 11, Ill.)

1–4. Semiconductor Symposium, Cleveland, Ohio. (M. F. Lamorte, Semiconductor Dept., Westinghouse Electric Corp., Youngwood, Pa.)

1–5. American Inst. of Electrical Engineers, fall general, Chicago, Ill. (N. S. Hibshman, AIEE, 33 W. 39 St., New York 18.)

1–5. International Cong. on Medical Records, 2nd, Washington, D.C. (Miss G. L. Perkins, American Assoc. of Medical Record Librarians, 510 N. Dearborn St., Chicago 10, Ill.)

1–10. Weights and Measures, international committee, Paris, France. (C. Volet, International Bureau of Weights and Measures, Pavillon de Breteuil, Sevres (Seine-et-Oise), France.)

2–14. Engineers Cong., 2nd international Federation of National Associations of Engineers, Zurich, Switzerland. (Federation Internationale d'Associations Nationales d'Ingenieurs, 19, rue Blanche, Paris 9e, France.)

8. Science and Human Welfare, international conf., American Inst. of Geonomy and Natural Resources, Washington, D.C. (R. M. Field, AIGNR, South Duxbury, Mass.)

8–10. National Clay Conf., 5th, Urbana, Ill. (R. E. Grim, Univ. of Illinois, Urbana.)

8–12. American College of Surgeons, 42nd annual clinical cong., San Francisco, Calif. (ACS, 40 E. Erie St., Chicago 11, Ill.)

8–12. International Decennial Review Conf. on Tissue Culture, Woodstock, Vt. (P. R. White, Jackson Memorial Laboratory, Bar Harbor, Me.)

8–12. National Metal Cong., 38th annual, Cleveland, Ohio. (American Inst. of Mining, Metallurgical and Petroleum Engineers, 29 W. 39 St., New York 18, N.Y.)

8–12. Pan-American Federation of Engineering Societies, 4th convention, Mexico, D.F., Mexico. (S. E. Reimel, Engineers Joint Council, 29 W. 39 St., New York 18.)

8–13. International Cancer Cytology Cong., Chicago, Ill. (A. H. Dearing, College of American Pathologists, Prudential Plaza, Chicago 1.)

9–10. Air Research and Development Command Science Symposium (classified), 4th annual, Boston, Mass. (Headquarters, ARDC, U.S. Air Force, P.O. Box 1395, Baltimore 3, Md.)

9–12. American Dietetic Assoc., 39th annual, Milwaukee, Wis. (Mrs. T. Pollen, ADA, 620 N. Michigan Ave., Chicago 11, Ill.)

9–15. World Medical Assoc., 10th gen-

eral assembly, Havana, Cuba. (L. H. Bauer, WMA, 345 E. 46 St., New York, N.Y.)

10–12. Indiana Acad. of Science, Bloomington. (W. A. Daily, Eli Lilly Research Laboratories, Indianapolis 6, Ind.)

10–18. Arid Zone Climatology with Special Reference to Microclimatology, international symposium, Melbourne and Canberra, Australia. (UNESCO, 19 Avenue Kléber, Paris 16e, France.)

11–12. International Scientific Radio Union, U.S. National Committee, Berkeley, Calif. (J. P. Hagen, 2101 Constitution Ave., NW, Washington 25.)

14–17. Society of American Foresters, Memphis, Tenn. (H. Clepper, SAF, 17th and Pennsylvania Ave., NW, Washington 6.)

14–19. American Acad. of Ophthalmology and Otolaryngology, annual, Chicago, Ill. (W. L. Benedict, 100 First Ave. Bldg., Rochester, Minn.)

15–17. Assoc. of Official Agricultural Chemists, annual, Washington, D.C. (W. Horwitz, Box 540, Benjamin Franklin Station, Washington 4.)

15–17. Soil Conservation Soc. of America, Tulsa, Okla. (H. W. Pritchard, SCSA, 1016 Paramount Bldg., Des Moines, Iowa.)

15–18. American Veterinary Medical Assoc., annual, San Antonio, Tex. (J. G. Hardenbaugh, AVMA, 600 S. Michigan Ave., Chicago 5, Ill.)

15–19. American Soc. of Civil Engineers, annual, Pittsburgh, Pa. (W. H. Wisely, ASCE, 33 W. 39 St., New York 18.)

15–26. New York Acad. of Medicine, annual graduate fortnight, New York, N.Y. (Secretary, Graduate Fortnight, NYAM, 2 E. 103 St., New York 29.)

16–17. National Acad. of Economics and Political Science, Washington, D.C. (D. P. Ray, George Washington Univ., Washington 6.)

16–18. Conference on Magnetism and Magnetic Materials, Boston, Mass. (T. O. Paine, Measurements Laboratory, General Electric Co., West Lynn, Mass.)

17–19. Symposium on Antibiotics, 4th annual, Washington, D.C. (H. Welch, Div. of Antibiotics, Food and Drug Administration, U.S. Dept. of Health, Education, and Welfare, Washington 25.)

18–19. Institute of Management Sciences, 3rd annual, Los Angeles, Calif. (C. W. Churchman, Case Inst. of Technology, University Circle, Cleveland 1, Ohio.)

18–20. Optical Soc. of America, semiannual, Lake Placid, N.Y. (A. C. Hardy, Massachusetts Inst. of Technology, Cambridge 39.)

21–23. American College of Apothecaries, Dallas, Tex. (R. E. Abrams, Hamilton Court, 39th & Chestnut St., Philadelphia 4, Pa.)

21–27. Iberian-Latin American Cong. of Dermatology, 3rd, Mexico City, Mexico. (Centro Dermatológico Pascua, Calle Dr. Garciadiego 21, Mexico 7, D.F.)

22–24. American Standards Assoc., 38th annual, New York, N.Y. (ASA, 70 E. 45 St., New York 17.)

22–25. American Soc. for Pharmacology and Experimental Therapeutics, Louisville, Ky. (H. Hodge, Dept. of Pharmacology, Univ. of Rochester, Rochester, N.Y.)

22–26. National Safety Cong., Chicago, Ill. (R. L. Forney, National Safety Council, 425 N. Michigan Ave., Chicago, 11.)

22–27. Endocrine Soc., 8th annual postgraduate assembly, Houston, Tex. (Office of Dean, Univ. of Texas, Postgraduate School of Medicine, Texas Medical Center, Houston 25.)

22–2. Industrial Forestry Seminar, New Haven, Conn. (E. T. F. Wohlenberg, Industrial Forestry Dept., Yale Univ., New Haven.)

23. American Soc. of Safety Engineers, annual, Chicago, Ill. (J. B. Johnson, ASSE, 425 N. Michigan Ave., Chicago 11.)

25–26. National Soc. of Professional Engineers, White Sulphur Springs, W.Va. (P. H. Robbins, 2029 K St., NW, Washington 6.)

26–29. American Heart Assoc., annual, scientific sessions, Cincinnati, Ohio. (Medical Director, AHA, 44 E. 23 St., New York 10.)

27. Eastern Psychiatric Research Assoc., New York, N.Y. (T. R. Robie, 676 Park Ave., East Orange, N.J.)

29–30. East Coast Conf. on Aeronautical and Navigational Electronics, 3rd annual, Baltimore, Md. (W. D. Crawford, Westinghouse Electric Corp., Air Arm Div., Friendship International Airport, Baltimore 27.)

29–1. Conference on Climatology sponsored by American Meteorological Soc., Asheville, N.C. (K. C. Spengler, 3 Joy St., Boston 8, Mass.)

29–1. Society of Exploration Geophysicists, annual, New Orleans, La. (G. A. Grimm, Tide Water Associated Oil Co., Box 2131, Midland, Tex.)

29–2. Convention on Ferrites, Institution of Electrical Engineers, London, England. (Secretary, IEE, Savoy Place, London, W.C.2.)

31. Society of Vertebrate Paleontology, Minneapolis, Minn. (J. T. Gregory, SVP, Peabody Museum of Natural History, Yale Univ., New Haven, Conn.)

31–1. Western Area Development Conf., 3rd, Phoenix, Ariz. (C. Green, Mountain States Office, Stanford Research Inst., Phoenix.)

31–2. Geological Soc. of America, annual, Minneapolis, Minn. (H. R. Aldrich, GSA, 419 W. 117 St., New York 27.)

31–2. Mineralogical Soc. of America, Minneapolis, Minn. (C. S. Hurlbut, Jr., 12 Geological Museum, Oxford St., Cambridge 38, Mass.)

31–2. Soc. of Economic Geologists, annual, Minneapolis, Minn. (O. N. Rove, 30 E. 42 St., New York 17.)

31–3. American Soc. of Tropical Medicine and Hygiene, New Orleans, La. (J. E. Larsh, Jr., School of Public Health, Univ. of North Carolina, Chapel Hill.)

November

1–2. Society for Applied Spectroscopy, 11th annual, New York, N.Y. (F. M.

Biffen, Johns-Manville Research Center, Manville, N.J.)

1–3. Association of Geology Teachers, annual, Chicago, Ill. (C. E. Prouty, Dept. of Geology, Univ. of Pittsburgh, Pittsburgh 13, Pa.)

5–7. Paleontological Soc., annual, Minneapolis, Minn. (H. B. Whittington, Museum of Comparative Zoology, Harvard Univ., Cambridge, Mass.)

6–15. International Grassland Cong., 7th, Palmerston, New Zealand. (S. H. Saxby, P.O. Box 2298, Wellington, New Zealand.)

7–9. Electrical Techniques in Medicine and Biology, 9th annual conf., New York, N.Y. (E. D. Trout, X-Ray Dept., General Electric Co., Milwaukee 1, Wis.)

7–9. Society of Rheology, annual, Pittsburgh, Pa. (W. R. Willets, Titanium Pigment Corp., 99 Hudson St., New York 13.)

8–9. Canadian High Polymer Forum, 7th, Sarnia, Ont. (M. H. Jones, Ontario Research Foundation, 43 Queen's Park, Toronto 5, Ont.)

8–10. Gerontological Soc., annual, Chicago, Ill. (N. W. Shock, Baltimore City Hospitals, Baltimore 24, Md.)

10. Society for the Scientific Study of Religion, fall meeting, Cambridge, Mass. (R. W. Burhoe, American Acad. of Arts and Sciences, Cambridge 36.)

11–12. American Soc. for the Study of Arteriosclerosis, annual, Chicago, Ill. (R. G. Gould, P.O. Box 1663, Los Alamos, N.M.)

11–17. Cardiology, 5th Inter-American cong. of, Havana, Cuba. (I. Chavez, Calzada de la Piedad 300, Mexico, D.F., Mexico.)

12–14. Association of Military Surgeons of the U.S., annual, Washington, D.C. (S. E. Womeldorph, AMSUS, Suite 718, 1726 Eye St., NW, Washington 6.)

12–15. American Petroleum Inst., 36th annual, Chicago, Ill. (API, 50 W. 50 St., New York 20.)

12–16. American Public Health Assoc., 84th annual, Atlantic City, N.J. (R. M. Atwater, 1790 Broadway, New York 19.)

12–16. American Soc. of Agronomy, annual, Cincinnati, Ohio. (L. G. Monthey, 2702 Monroe St., Madison 5, Wis.)

13–15. Historical Development of Physiological Thought, symposium, Brooklyn, N.Y. (E. Goodwin, State Univ. of New York, College of Medicine, Brooklyn 3.)

14–16. Optics and Microwaves, symp., Washington, D.C. (Symp. on Optics and Microwaves, P.O. Box 355, Falls Church, Va.)

15–16. Society of Technical Writers, jointly with Assoc. of Technical Writers and Editors, New York, N.Y. (S. F. Shapiro, STW, P.O. Box 22, Newton Centre 59, Mass.)

15–17. Acoustical Soc. of America, Los Angeles, Calif. (W. Waterfall, ASA, 57 E. 55 St., New York 22.)

18–25. National Meeting of Surgeons, Mexico City, Mexico. (Intern. Acad. of Proctology, 147–41 Sanford Ave., Flushing, N.Y.)

18–9. Pacific Science Cong., 9th, Bangkok, Thailand. (Secretary, Pacific Sciences Assoc., Bishop Museum, Honolulu 17, Hawaii.)

19–20. Entomological Soc. of America, Eastern Branch, Atlantic City, N.J. (B. F. Driggers, Experiment Station, New Brunswick, N.J.)

22–3. International Cong. of Industrial Chemistry, 29th, Paris, France. (J. Gerard, Société de Chimie Industrielle, 28, rue Saint-Dominique, Paris VII^{e}.)

23–24. American Mathematical Soc., Evanston, Ill. (E. G. Begle, 207 Leet Oliver Memorial Hall, Yale Univ., New Haven 11, Conn.)

23–24. American Physical Soc., Chicago, Ill. (K. K. Darrow, APS, Columbia Univ., N.Y. 27.)

23–24. American Soc. of Animal Production, annual, Chicago, Ill. (W. M. Beeson, Dept. of Animal Husbandry, Purdue Univ., W. Lafayette, Ind.)

25–30. American Rocket Soc., annual, New York, N.Y. (J. J. Harford, ARS, 29 W. 39 St., New York 18.)

25–30. American Soc. of Mechanical Engineers, annual, New York, N.Y. (C. E. Davies, ASME, 29 W. 39 St., New York 18.)

26–28. American Soc. of Refrigerating Engineers, Boston, Mass. (R. C. Cross, ASRE, 234 Fifth Ave., New York 1.)

26–30. Automation Exposition, 3rd intern., New York, N.Y. (TIAE, Richard Rimbach Associates, Inc., 845-A Ridge Ave., Pittsburgh 12, Pa.)

27–30. American Medical Assoc., clinical, Seattle, Wash. (G. F. Lull, AMA, 535 N. Dearborn St., Chicago 10, Ill.)

28–30. American College of Cardiology, 5th interim, Pittsburgh, Pa. (P. Reichert, ACC, Empire State Bldg., New York, N.Y.)

28–30. International Conf. on Ozone, 1st, Chicago, Ill. (C. E. Thorp, Armour Research Foundation, 35 W. 33 St., Chicago 16.)

30–1. Oklahoma Acad. of Science, Stillwater. (D. E. Howell, Entomology Dept., Oklahoma A. & M. College, Stillwater.)

30–1. Tennessee Acad. of Science, Murfreesboro. (D. Caplenor, Dept. of Biology, Peabody College, Nashville 4, Tenn.)

Special Discount to Members of the American Association for the Advancement of Science

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Vol. I. *Contributions to the Theory of Statistics*

Contributors: Joseph Berkson; Z. W. Birnbaum; Herman Chernoff and Herman Rubin; Aryeh Dvoretzky; Sylvain Ehrenfeld; G. Elfving; Ulf Grenander and Murray Rosenblatt; J. L. Hodges, Jr., and E. L. Lehmann; Wassily Hoeffding; Samuel Karlin; L. Le Cam; Herbert Robbins; Murray Rosenblatt; Charles Stein; B. L. Van der Waerden.

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Vol. IV. *Contributions to Biology and Problems of Health*

Contributors: James F. Crow and Motoo Kimura; Everett R. Dempster; Jerzy Neyman, Thomas Park and Elizabeth L. Scott; M. S. Bartlett; A. T. Bharucha-Reid; Chin L. Chiang, J. L. Hodges, Jr., and J. Yerushalmy; Jerome Cornfield; David Kendall; William F. Taylor.

Cloth. List Price $5.75
Publication Date: 5 June 1956

Vol. V. *Contributions to Econometrics, Industrial Research, and Psychometry*

Contributors: Kenneth J. Arrow and Leonid Hurwicz; Edward W. Barankin; C. West Churchman; Patrick Suppes; Albert H. Bowker; Cuthbert Daniel; Milton Sobel; T. W. Anderson and Herman Rubin; Frederick Mosteller; Herbert Solomon.

Cloth. List Price $5.75
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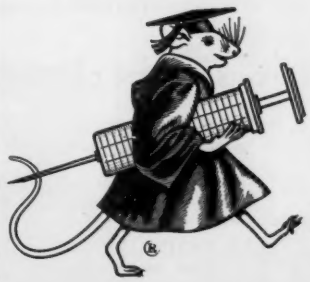

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1. The two-session general symposium, "Moving Frontiers of Science," arranged by the Committee on AAAS Meetings.
2. The six sessions of the Conference on Scientific and Technical Editorial Problems.
3. Details of the anniversary celebrations of the AAAS-Gordon Research Conferences, Botanical Society of America, Freud *et al.*
4. Programs of the 18 AAAS sections (symposia and contributed papers).
5. Programs of the more than 80 participating societies.
6. The Special Sessions: AAAS, Academy Conference, Conference on Scientific Manpower, National Geographic Society, Phi Beta Kappa, RESA, Sigma Xi.
7. Details of the Hotel Statler—center of the Meeting—and other hotels and session sites.
8. Titles of the latest foreign and domestic scientific films to be shown in the AAAS Science Theatre.
9. Exhibitors in the 1956 Annual Exposition of Science and Industry and descriptions of their exhibits.

Directory content

1. AAAS officers, staff, committees for 1956.
2. Complete roll of AAAS presidents and their fields.
3. The more than 265 affiliated organizations.
4. Historical sketch and organization of the Association; the 1955 revised Constitution and Bylaws.
5. Publications of the Association.
6. AAAS Awards and Grants—including all past winners.
7. Membership figures by sections.
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9. Local committees.
10. Future Meetings of the AAAS through 1962.
11. New and current activities of the AAAS.

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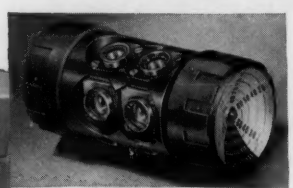

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